Flash Memory Summit

UFSA
Universal Flash Storage Association

CMOB-302-1 : Mobile Applications Reach New Frontiers

Aug 9, 2018

Organizer :

* HeeChang Cho, UFSA Marketing Committee Chair
* Mian Quddus, JEDEC BOD Chair
* Lisa Rhoden, UFSA President

Session Chair :

* Desi Rhoden, JEDEC JC42 Chair

What you will learn from this session

- In today's session, you will meet key ecosystem companies and learn the technology of UFS & UFS Card as well as future plans

- You will learn about a UFS controller chip, a USB3.0-to-UFS bridge chip, UFS usage in data centers, file system support, ways to provide support of both UFS and micro SD Cards with a single socket, and related UFS technologies

- Your company will be able prepare your next year state-of-the-art UFS Card host products and UFS Card device products to be a winner in your Market.

CMOB-302-1 : Mobile Applications Reach New Frontiers

- Agenda for today

CMOB-302-1: Mobile Applications Reach New Frontiers (Consumer/Mobile Applications Track)				time(minute)			
Session	#	topic to talk & panel discussion	by	time period	speech	Q&A	total
Part-#1 (2:10~3:15 ,75Minutes)	1	About UFS position in JEDEC	JEDEC BOD Chair (Mian Quddus)	2:10~2:15	5	0	5
	2	How UFSA is helping your new business	UFSA president (Lisa Rhoden)	2:15~2:20	5	0	5
	3	Annual Update on UFS & UFS Card	Montage (Desi Rhoden)	2:20~2:30	10	0	10
	4	For Future Mobile Application, UFS Card	Phison (Filipe Ramos)	2:30~2:50	15	5	20
	5	UFS Technology details and its advantages	Samsung (HeeChang Cho)	2:50~3:15	10	5	15
	6	Practical Solution to build UFS Card supporting Host system	SMI (Robert Hsieh)	3:15~3:20	10	5	15
	7	Pannel-discussion-#1 :: Applications, Technology, System Design Support	(Samsung+Phison+SMI)	3:20~3:35	0	15	15
		Coffee Break(10 min) : UFS Card performance Demo Displaying & Q&A		3:35~3:45			10
Part-#2 (3:30~4:45 ,75Minutes)	8	UFS for data center usages	MicroSoft (Lee Prewitt)	3:45~4:00	10	5	15
	9	Optimizing for hardware: how to maintain storage performance in the long-run	Tuxera (Mikko)	4:00~4:15	10	5	15
	10	Practical Solution to support both UFS Card and microSD card using single slot	Amphenol (Zhineng)	4:15~4:25	5	5	10
	11	Measurement solution for integrating ultra-high speed UFS storage	KeySight (Perry Keller)	4:25~4:40	10	5	15
	12	Pannel-discussion-#2 :: Business advantages, Business support	(MicroSoft+Tuxera+Amphenol+KeySight)	4:40~5:00	0	20	20
		total time(Part-#1(85min) + Break(10min) + Part-#2(75min))					170

JEDEC BOD Chair

	Mian Quddus is heavily involved in the JEDEC Standardization Activities. Mian is the Chairman of JEDEC BOD of Directors. He also Chairs the JC-45 Committee: DRAM Modules and the JC-64 Committee: Embedded Memory Storage and Removable Memory Cards. Mian has a BSEE from California University at Fresno and an MBA from University of Phoenix.
Mian Quddus, Sr Director, Mian.quddus@Samsung.com	(Presentation) What is the position of UFS in JEDEC

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About UFS in JEDEC

Aug 9, 2018

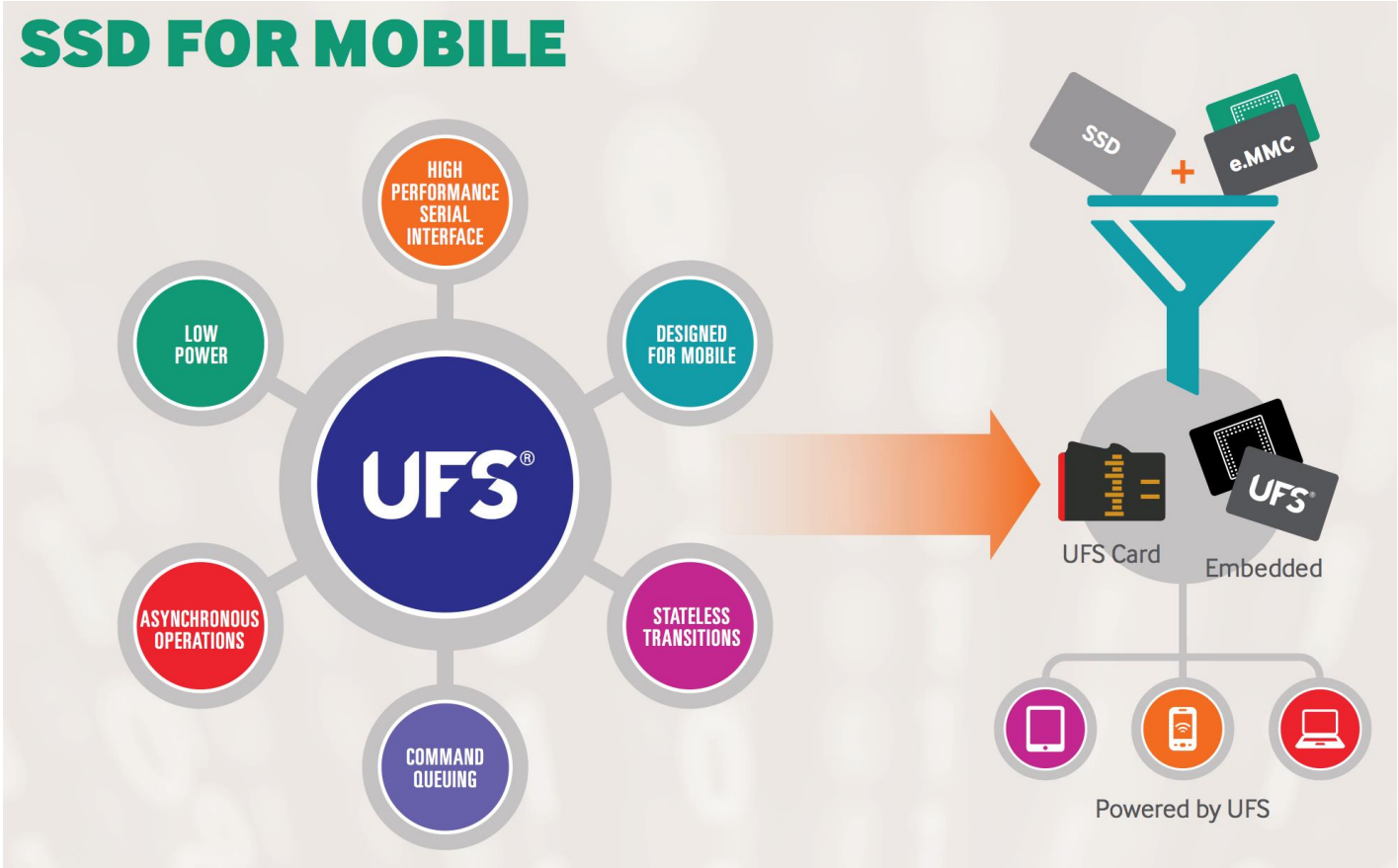
JEDEC BOD chairperson

Mian Quddus

UFS position in JEDEC

- JEDEC (www.jedec.org)
  - Global leader in developing open standards for the semiconductor industry, with more than 3,000 volunteers representing nearly 300 member companies.
  - The most major semi-conductor standards in the IT industry.
    - DRAM based :
      - DDR (for PC DRAM)
      - LPDDR (for Low Power DDR for mobile IT)
      - GDDR (Graphic DRAM used for Graphic Card)
    - FLASH based :
      - **UFS (replacing previous eMMC standard)**
      - **UFS Card (removable/external UFS Storage)**
      - SSD form factor (e.g. NGSFF)
      - NVM future memory and more
  - ➔ UFS & UFS Card are the Mobile Storage Standard in JEDEC !

UFS is SSD for Mobile



Summary

- JEDEC is helping the industry by defining standards for:
  - DRAM and related module products
  - NAND based Storage like UFS and UFS Card
  - SSD

- UFS is the key technology for NAND based mobile storage.

Thanks

UFSA President

Lisa is President of the Universal Flash Storage Association (UFSA)

Previously she was Vice President of Advanced Memory International Inc. (AMI2) where she coordinated the development of industry common reference PCB files for Memory DIMMS for DDR and DDR2

Lisa has a BSEE from Colorado State University, with minors in Computer Science and Mathematics, and a Technology MBA from Arizona State University

lisa@ufsa.org

(Presentation) How UFSA is helping your business

How UFSA is helping your business

Aug 9, 2018

UFSA President

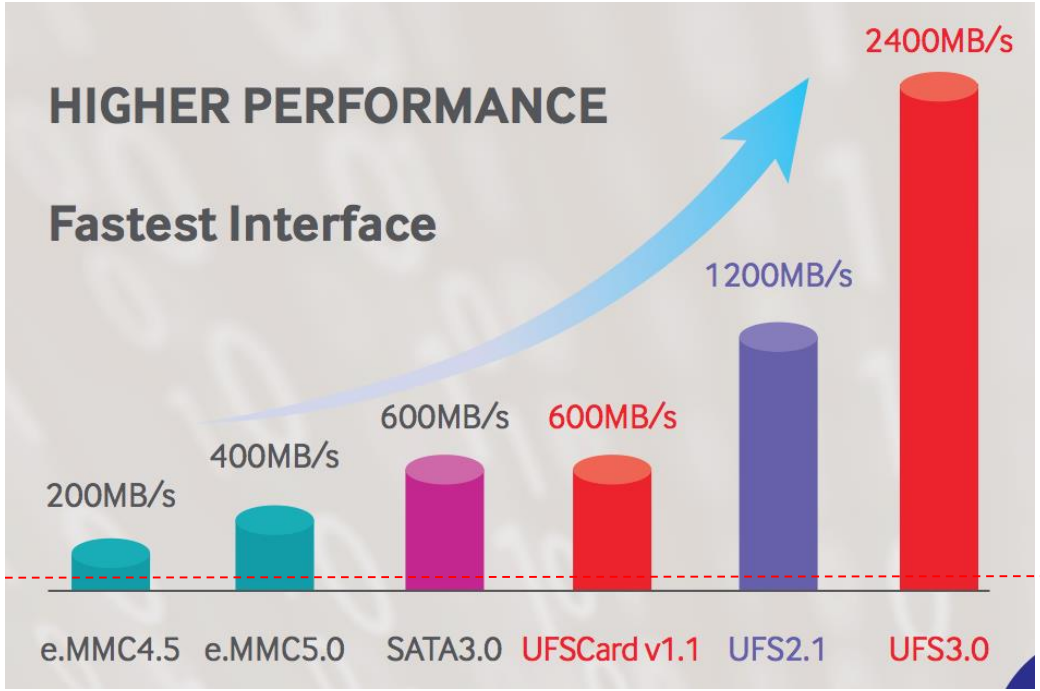
Lisa Rhoden

Certification/Promotion of UFS & UFS Cards and building ecosystem together

- UFSA (www.ufsa.org)
  - Providing Certification/Logo Program for UFS and UFS card products
    - → Providing certification test cases, test procedures and proven equipment information.
    - → Improving interoperability among host devices and UFS/UFS Card devices
  - Industry Association for promoting UFS and UFS Card technology and building infrastructure together
  - Member companies

Evolution of UFS & UFS Card

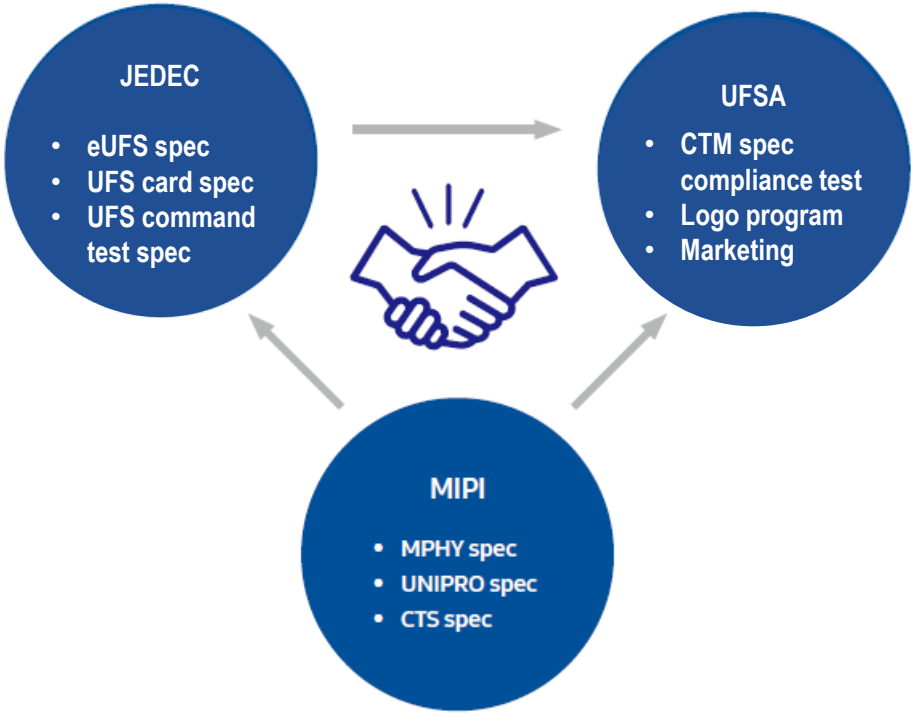
- UFS is replacing eMMC
- UFS Card is expected to replace SD Card



Future UFS Performance Will be Even higher

Collaboration with JEDEC and MIPI

- To develop the UFS CTM (Compliance Test Matrix), UFSA has MOUs with JEDEC and MIPI.



UFSA Booth Location

- UFSA booth is #707.

Thanks

Executive VP, Montage Technology
Chairman JEDEC Memory Committee

	Executive Vice President with Montage Technology Chairman JEDEC JC-42 Memory Committee Previously Desi was EVP with Inphi Corp Desi has Bachelors and Masters degrees in Electrical Engineering from Colorado State University Desi resides in Austin Texas, where he enjoys running, hiking and cutting cedar
Desi Rhoden, EVP of Montage, desi.rhoden@montage-tech.com	(Presentation) Annual Update on UFS & UFS Card

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Annual Update on UFS and UFS Card

Aug 9, 2018

Session Chair of CMOB-302-1
(UFSA BOD Member, JEDEC JC42 Chair)

Desi Rhoden

embedded UFS Status

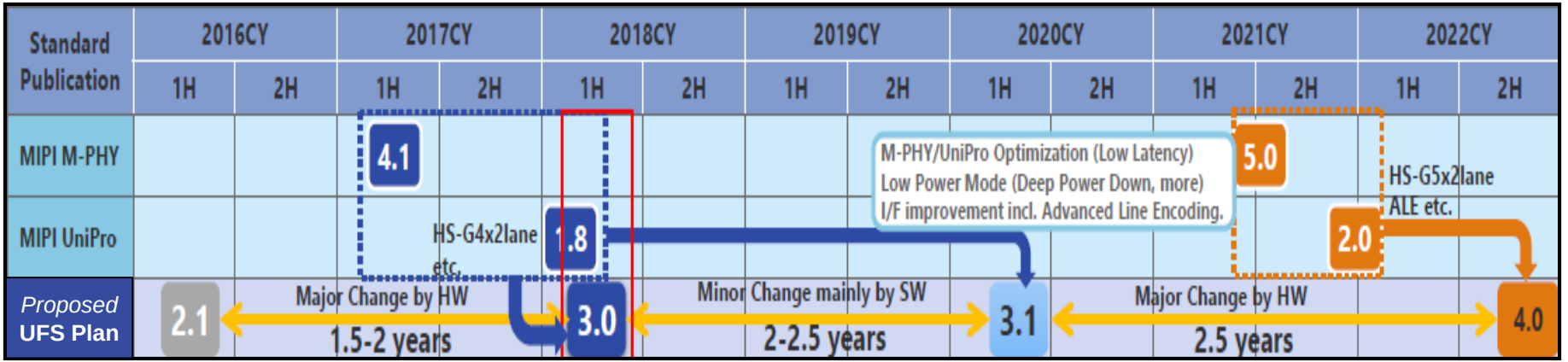
- UFS v3.0 (published ’18 March) for 5G and Automotive
  - 2x Performance over UFS 2.1
    - : up to 2.4 GB/sec (1.2Gbps x 2 lane) by adopting MIPI HS-G4.
  - Lower Power Consumption
    - 2.5V VCC and 1.2V VCCQ
  - Automotive Support: New features
    - JEDEC Auto Grade 2 support (-40 ~ 105 C Tcase): extended range for Automotive environment
    - Temperature Event Notification Mechanism: to allow module level temperature management
    - Refresh operation: to allow improved data retention
  - Enhanced Security feature
    - 4 RPMB Regions and corresponding Security Keys enabled
  - Improved debug capability
    - Error history mode to provide detailed information directly from the device

UFS Card Status

- UFS Card v1.1 (published ‘18 March) power optimization
  - Mandatory 4 speed gear modes
    - PWM-G1 (used only during UFS device boot stage)
    - Normal Operating modes selectable by the host to optimize power/performance
      - HS-G1 (1.5Gbps)
      - HS-G2 (3 Gbps)
      - HS-G3 (6 Gbps)
  - Optimized Max Power Consumption
    - in RMS (100ms period) and in Peak (5us period)
    - 1.63 W Maximum while providing Max 600Mb/sec performance.

UFS & UFS Card Future Plans

- **Enabling AI, 5G and Automotive Era perfectly**
  - UFS Card v2.0(’20) doubles the performance to 1.2GB/sec (600MB/sec → 1.2GB/sec)
  - UFS 4.0 (’22) doubles the performance again to 4.8 GB/sec (2.4GB/sec → 4.8 GB/sec)
  - MIPI is collaborating with JEDEC to prepare the next revision of UFS



UFSA Compliance Activities

- CTM v1.3 release (’17 Sept)
  - Added Host Rx and Tx Testing
  - Added Interoperability Testing
- CTM v1.4 release (‘18 June)
  - Fixed minor errors in test cases

➔ UFS logo on product, packaging, web, etc. indicates product has passed UFS Certification

- The following UFS Cards have passed certification
  - Samsung (Saturn)
  - SMI (SM2750)
  - Phison (PS8311/8313)

➔ Check the UFSA website for other products that have passed UFS Certification

UFSA ecosystem

- UFS Card controller available today
  - Samsung
  - SMI
  - Phison
- Bridge Controller chip available today
  - SMI
  - JMicron
- Combo Socket available today
  - Amphenol

- Check the UFSA website for how to be involved in the future of UFS

Summary

- The experts are here today so ask questions - anytime
- Learn the specific details from those experts
- UFS embedded is already everywhere in the industry
- UFS Cards give you SSD performance in a removable card
- Future UFS will bring higher performance and low power
- Get everything you need to be involved in the exciting future of UFS

Thanks

(Title) For Future Mobile Application, UFS Card

	Filipe Rios began his professional career in Brazil designing customized R&D projects, machines and embedded electronics (FW & HW) for niche-specific applications. In 2012, he moved to Taiwan to join Phison Electronics Corp. With 13 years of experience in the technology field, Filipe is the Project Manager responsible for Phison UFS controllers all the way from planning, through development to marketing, also involved in product/roadmap alignment with NAND Flash manufacturers and customers' time to market.
Filipe Rios , filipe_rr@phison.com	Inheriting the benefits of UFS 2.1 internal storage, UFS Card significantly improves the capabilities of removable storage for mobile devices, cameras and IoT products in general that require thin and small memory card form factors. Deliver performance in SSD range, supporting the newest NAND Flash generations, with mobile-oriented power consumption and thermal constraints, packaged in a very small form factor is a challenge that UFS card controllers need to overcome. Cutting edge architecture, efficient ECC engines, optimized management of Flash Translation Layer (FTL) and other aspects are essential to build a product that delivers quality and is cost effective, which highlights the importance of having total control over the design.

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UFSA Universal Flash Storage Association

UFS Card

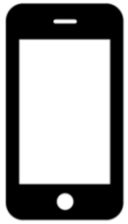
For Future Mobile Applications

Filipe R. Rios

UFS – Full-Duplex Interface

Half-Duplex

Up to 104MB/s
(UHS-I)

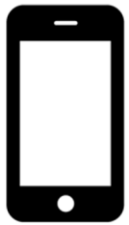


Data **only** flows in **one direction at a time.**

Full-Duplex

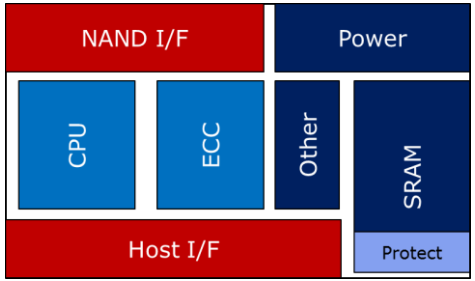
Gear 3 x 1-Lane

Each Lane Gear 3:
Up to 600MB/s

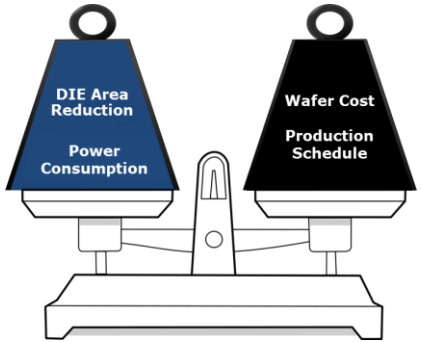


Data flows in **both directions simultaneously.**

Technology Behind the Scenes



General NAND Controller Block Diagram



Controller Process Investment (2xnm, 1xnm) Trade Off

High Throughput (600MB/s) & Rand. Performance, Low Latencies
- 32-bit powerful processor with SSD-like architecture, more channels & SRAM, HW accelerators, FW considerations

Low Power (Active < 1.63mW, room temp) and Heat
- ~50% of the power consumption limit as S
- Regulators/Detectors, peak power, thermal management
- Low Voltage Physical Layer

NAND: Constraints of Newer 3D TLC Processes
- LDPC + RAID ECC, Large RAM, Robust FW algorithms

Quality
- Robust and Widely tested SCSI command set
- SRAM with Protection for bit-flip, End-to-End data path

Validation
- Collaboration with host chipsets and customer

Major Challenge: Mobile Market Consolidation
- Global phone sales hitting saturation

Smartphones
Storage Trend and Expectations

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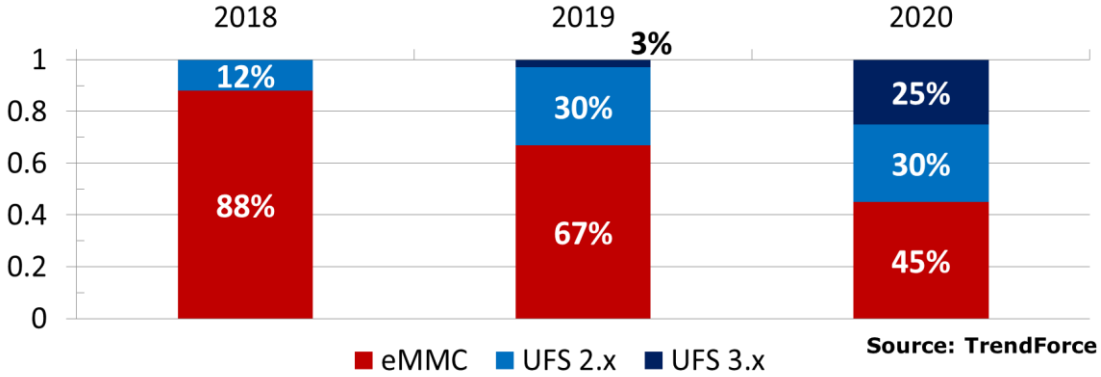
Assuming market size of 1.5b smartphones….



- Internal eMMC form factors:
  - Discrete eMMC / eMCP
- Internal UFS form factors:
  - Discrete UFS / uMCP

Year	**Flagship** **Most powerful devices for a given generation.**	**Mid and High-End** **Very powerful devices.** **Some are comparable to the flagship.**	**Low-End /Entry level** **Cost-oriented devices.** **Features performance just above minimum recommended to run the OS ver. & apps of current gen.**
2018	Internal Storage only UFS 2.1 x 2L	Internal: eMMC / UFS 2.1 - 2L Removable Storage: microSD UHS-I	Internal: eMMC Removable Storage: microSD UHS-I
2019	Internal Storage only UFS 3.0 x 2L	Internal: UFS 2.1 - 2L Removable Storage: UFS Card 1.1 / microSD UHS-1	Internal: eMMC / UFS 2.1 - 2L Removable Storage: microSD UHS-I
2020	Internal Storage only UFS 3.x or superior	Internal: UFS 2.1 - 2L / UFS 3.0 – 1L or superior Removable Storage: UFS Card 1.1 or superior	Internal: UFS 2.1 - 2L / UFS 3.0 – 1L / eMMC Removable Storage: UFS Card 1.1 or superior

Mobile Storage:
Embedded vs Removable Trend

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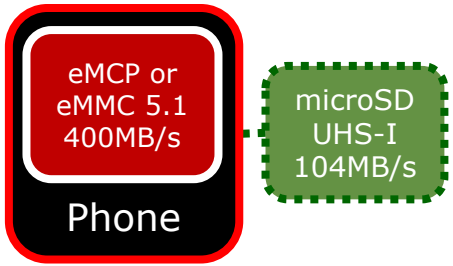
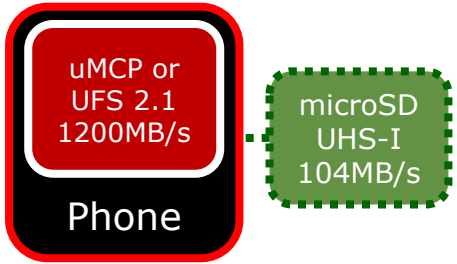
2018

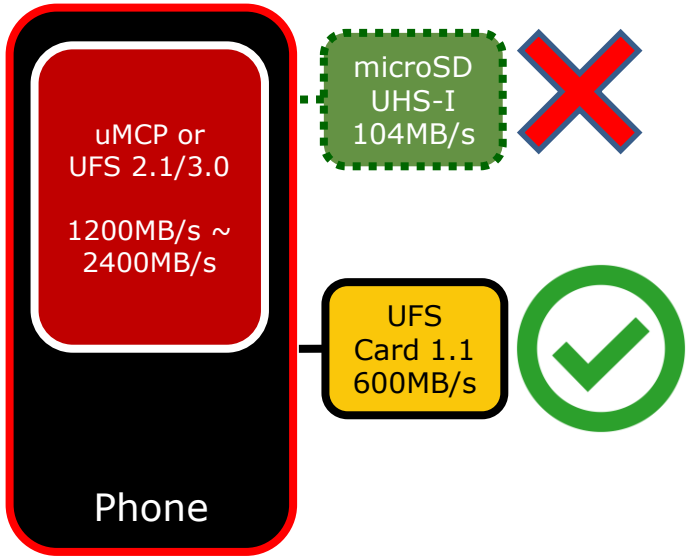


OK. 25% of internal I/F speed



Big Gap! Removable Storage Performance Under 10% of Internal

2019/2020



Removable storage more aligned (25~50%) with embedded in I/F speed

Android's Adoptable Storage Device means growing need for card seq. & random performance (IOPS)

UFS Card's high speeds eliminate the need to bring up various application level logos to guarantee seq. and random performances

Result: Great 8K video, 5G speed and APP compatibility. True expansion of internal storage possibility

UFS Card x SSD Performance

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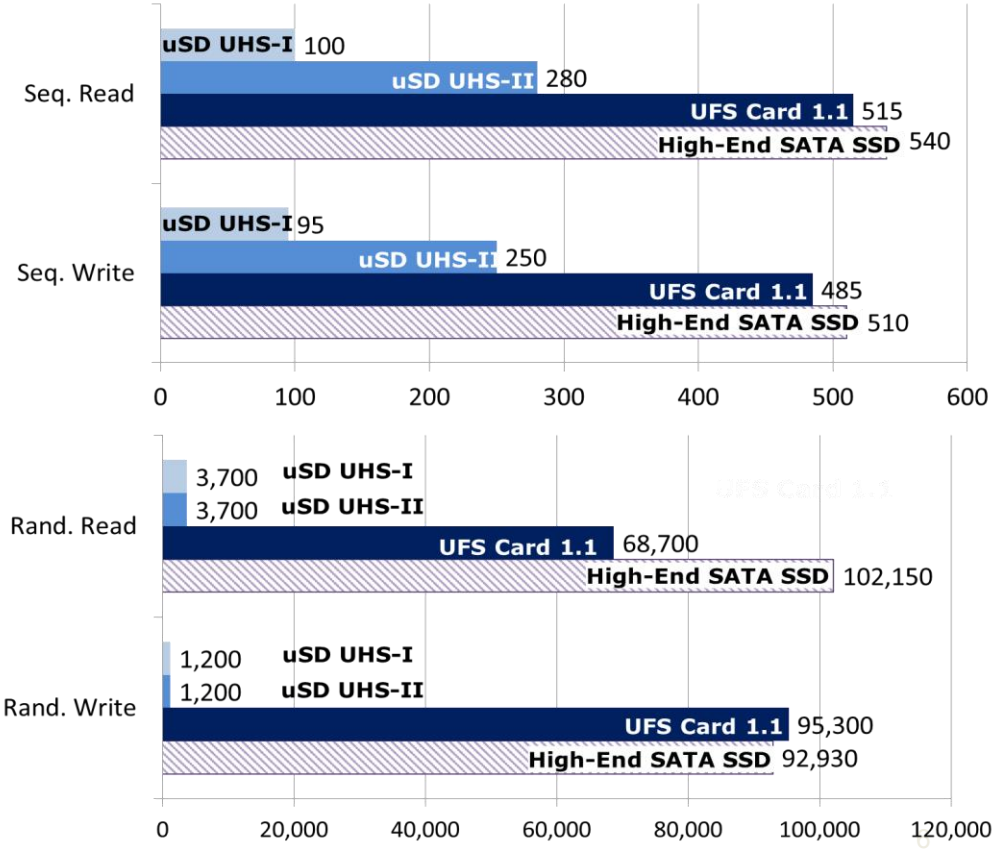
Sequential Read/Write (MB/s)

- **5 Times Faster than the fastest cards used by current smartphones (UHS-I)**
- **Similar to High-End SATA SSDs**

Random 4KB Read/Write (IOPS)

- **Over 15 Times Faster Read than the cards used by current smartphones (UHS-I)**
- **Over 70 Times Faster Write than the cards used by current smartphones (UHS-I)**
- **Similar random write performance to High-End SATA SSDs**



Technology Behind the Scenes

Embedded Controllers

- **For Tier-1 flagship phones**
- **Performance is top priority**
- Boost Random Read Performance from system
- Increase burst write performance
- Reduce standby power to increase battery life

Removable Controllers

- **For expansion cards**
- **Cost & Maturity will be prioritized**
- Performance can be inherited from embedded controllers
- Therefore, using controllers one generation behind would be ideal

PHISON
Knows What You Need

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Thank You

(Title) UFS Technology details and its advantages

	Hee Chang (Steve) Cho is a Principal Engineer and Software Architect at Samsung Electronics. He has 25 years of experience in the semiconductor industry. He has deeply experienced in development of a variety of hardware and software including micro-processor, Audio codecs, eMMC/SD and UFS etc. He has been Vice-Chair of the JEDEC JC64.1 committee on embedded storage and removable memory cards and Marketing Committee Chairperson for UFSA. He earned his Master's and Bachelor's degrees in computer science at KAIST, the Korean Advanced Institute of Science and Technology in Daejong, Korea.
HeeChang Cho, Principal Engineer & SW Architect, steve.cho@samsung.com	Samsung will deliver detail Advanced Architecture of UFS which is new mobile storage standard emerging in Mobile Industry.

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UFS Technology and Advantages

Aug 9th, 2018

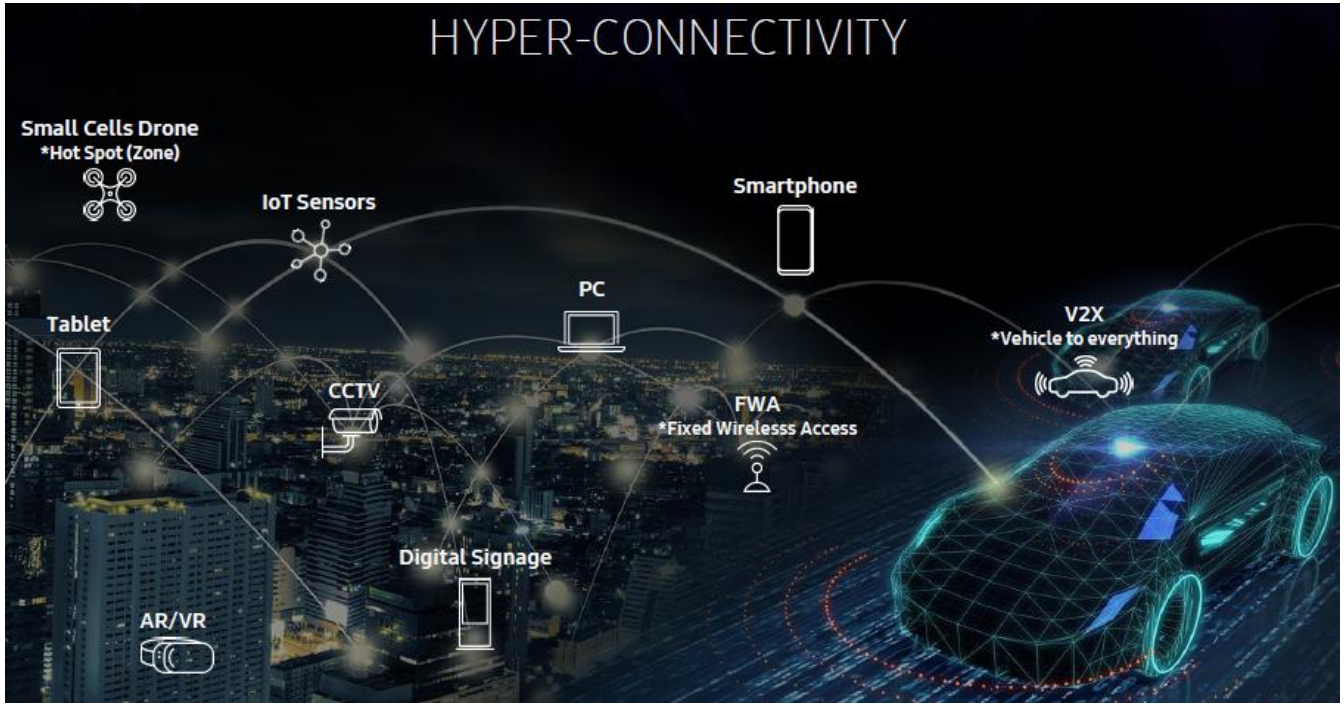
Samsung Electronics co. Ltd

HeeChang Cho

(steve.cho@samsung.com)

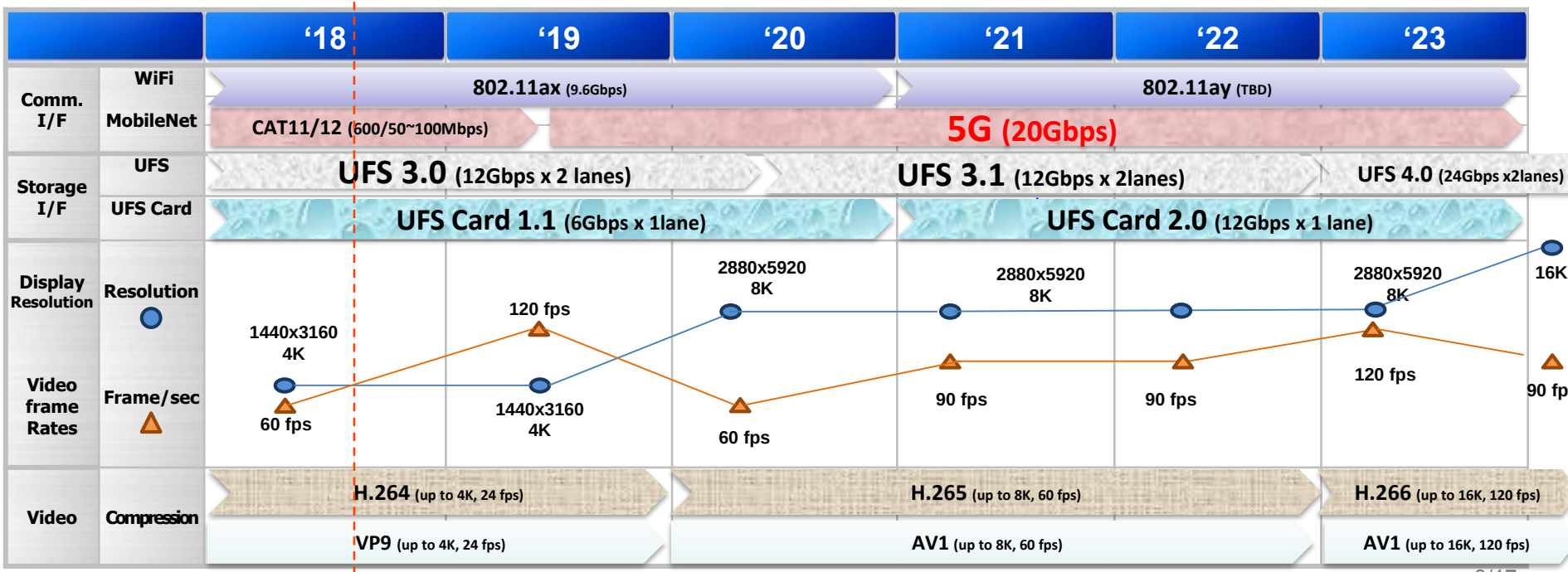
5G connecting Everything

- Numerous Devices will generate Big Data.
  - ➔ High Bandwidth storage with High Reliability is needed !



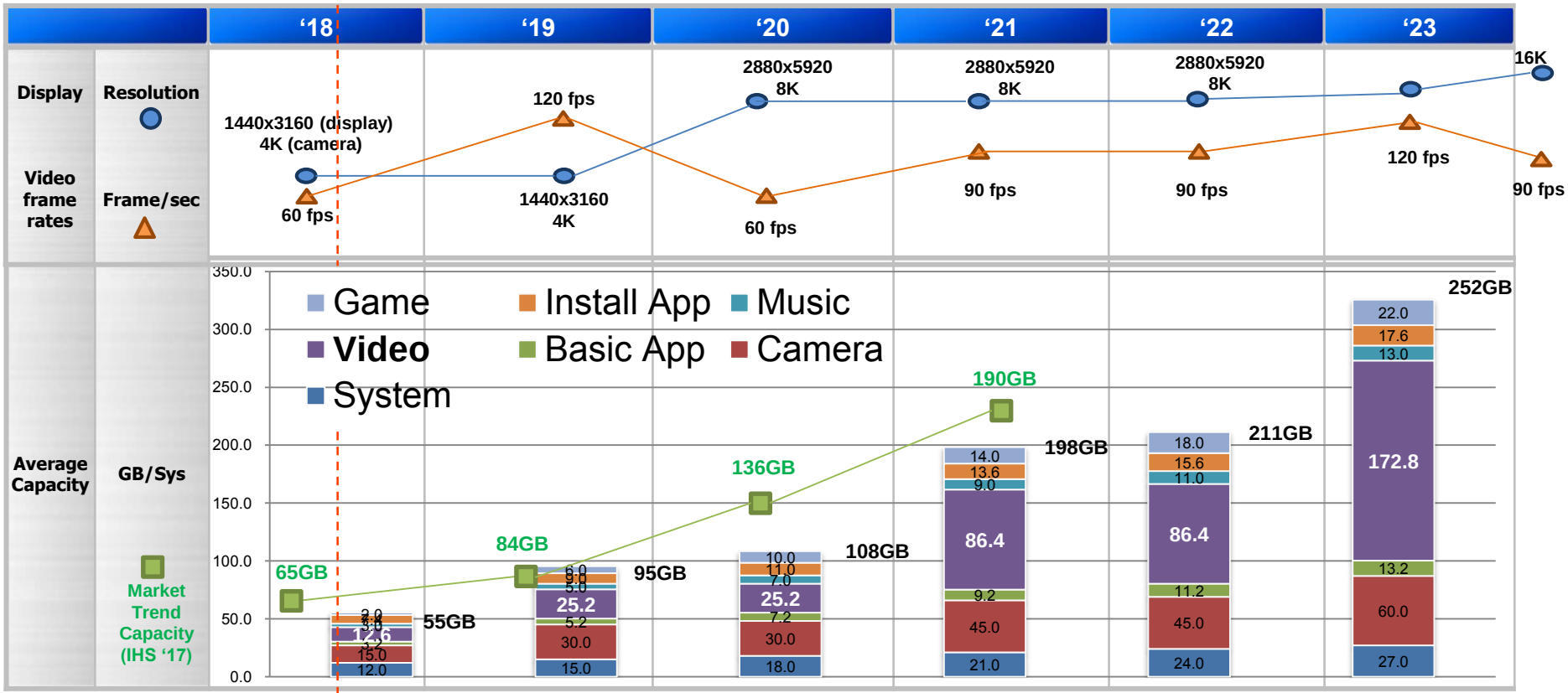
Demanding Higher Bandwidth

- New era is coming … Seamless Evolution
  - Network(5G, …)
  - Display(UHD, 8K, …)
  - New UX(AI, Triple Camera, …)



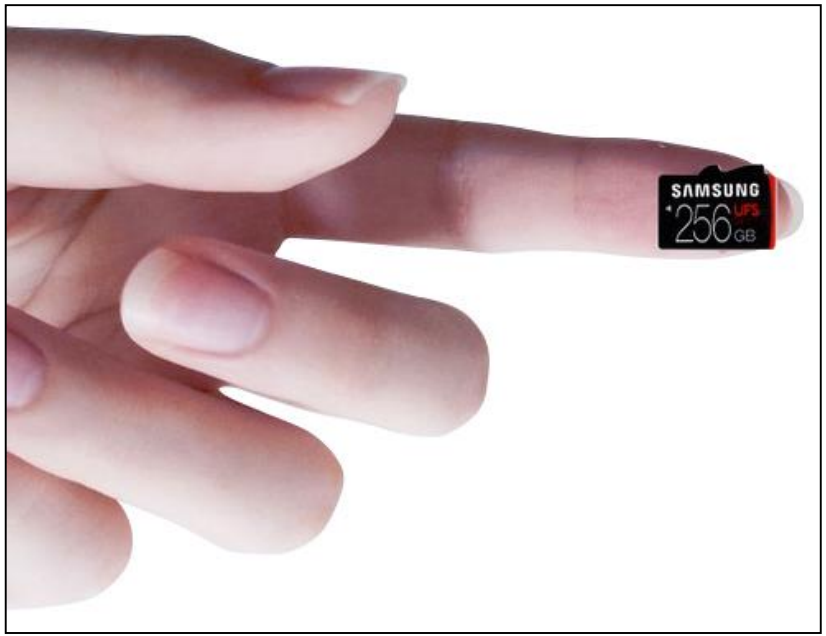
Demanding Higher Capacity

- More and faster storage, UFS Card, is needed as the contents size (UHD, 8K) and transfer speed(5G) increase



5G Storage Solution ➔ UFS & UFS Card !

- UFS Card as for external removable storage,
  - ➔ Fingernail size UFS Card, yet delivering **SSD performance**



Key Benefits of UFS and UFS Card

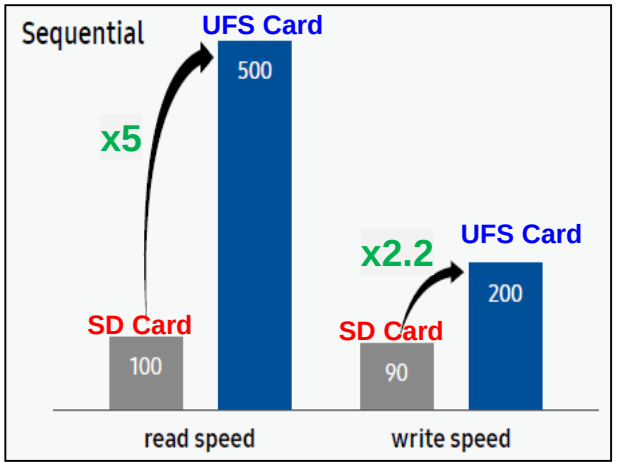
- Superior Performance as for Mobile storage
  - UFS Card with random write speeds up to 70 times faster than SD Card(*1)
- High Reliable Physical/Link with high speed differential signal
  - And, Industry Proven SCSI Command Architecture
- Lower Power Consumption
  - 0.2v signaling

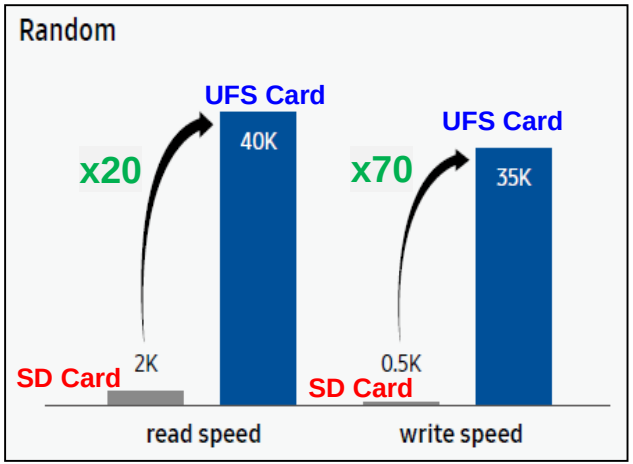
- + furthermore,
  - Royalty-Free UFS Card form factor
    - no more royalty for removable card business
  - JEDEC, UFSA and MIPI international standard organizations
    - supported and collaborated

(*1) SD Card in this material means SD Card in UHS-I mode. This type of SD Card are mostly spread nowadays, so SD card recognized by most end-user is UHS-I mode SD Card. For simplicity, it is noted in SD Card through this material. All comparison results in this materials is from the Samsung's UFS Card and SD Card which used same NAND, same capacity, and same test environments.

Superior Performance -1/3

- UFS Card vs. SD Card
  - 5x times higher performance in Sequential Read case. (ex) 5G, Movie, Game play, …
  - 70x time higher performance in Random Write case. (ex) IOT, SW install, Photo, …

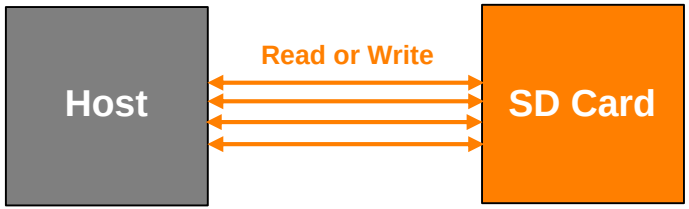




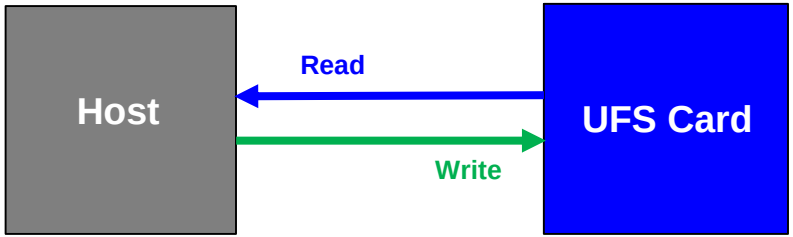
Superior Performance - 2/3 : Full Duplex

- UFS Card vs. SD Card
  - SD protocol is half-duplex which allow only one direction data transferring in lower speed(104MB/sec in Interface Maximum)
  - UFS protocol is full-duplex which allow both read/write direction data transferring in high speed (6 Gbps, i.e 600MB/sec in Interface Maximum)

SD Card
Half Duplex (Read or Write, one-by-one)



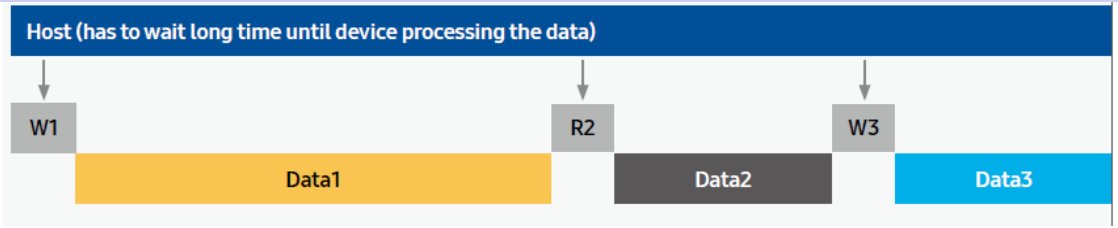
UFS Card
Full Duplex (Read and Write, in Parallel)



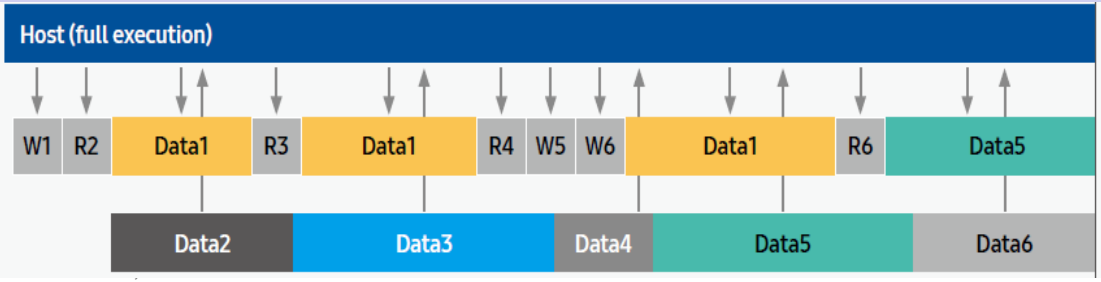
Superior Performance - 3/3 : Advance Async IO

- UFS Card vs. SD Card
  - UFS host can send commands continuously, even while the UFS card is transferring data for processing previous commands.
  - And an application can perform IO operations while other applications simultaneously run without sluggish performance.

SD Card (Old Sync IO Protocol, One at a time) → low performance, long latency, starvation problem



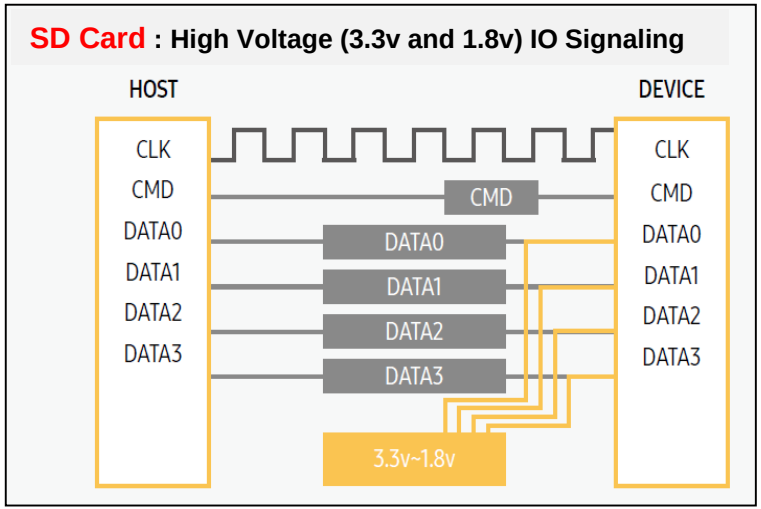
UFS Card (Advanced Async IO protocol, Tx/Tx in Parallel) → Ideal for Multi-processing

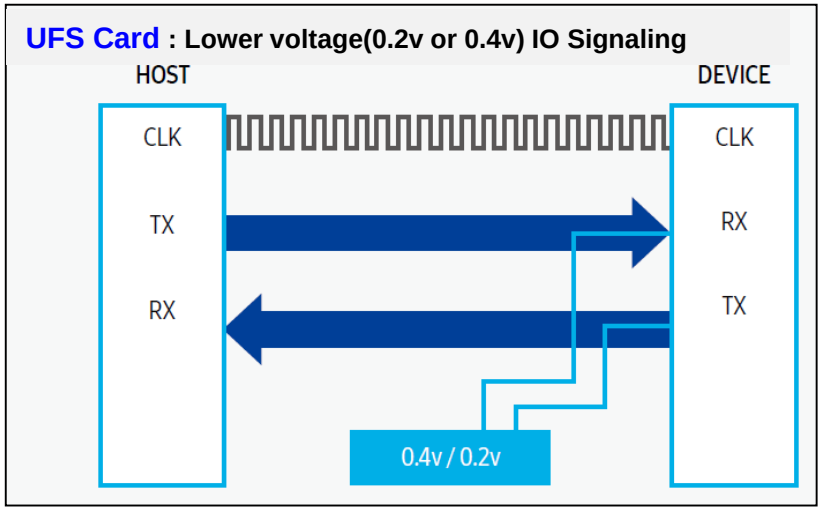


Power -1/3 : Low Power IO Signaling

- UFS Card vs.SD Card
  - SD Card requires 3.3V and 1.8V for IO signaling
  - UFS Card only requires 0.2V (or 0.4V) swing of one pair of differential signals

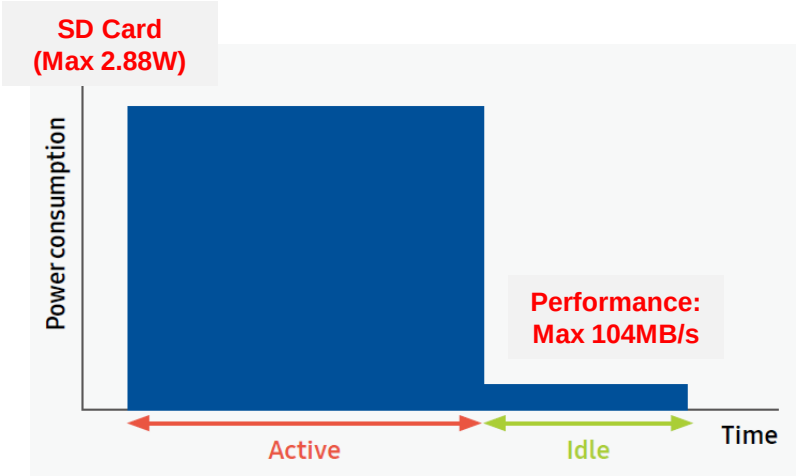
  ➔ dramatically reducing Power Consumption while showing superior performance

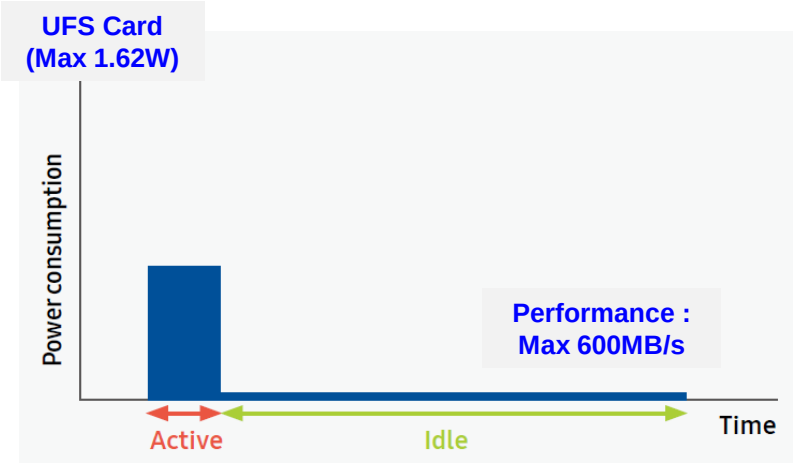




Power - 2/3 : Energy Efficiency

- UFS Card vs. SD Card
  - Max power consumption of UFS Card(1.62W) is less than SD Card(2.88W)
  - 10 times more energy efficient as UFS Card consumes less power than the SD Card in transferring the same amount of data
  - Longer staying in power-saving mode by processing IO quickly(5x ~ 70x faster IO processing)





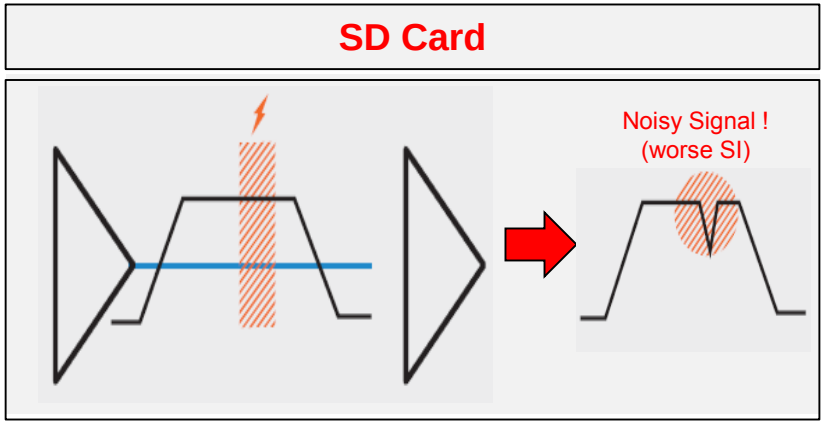
Power -3/3 : Reliability (affecting system stability)

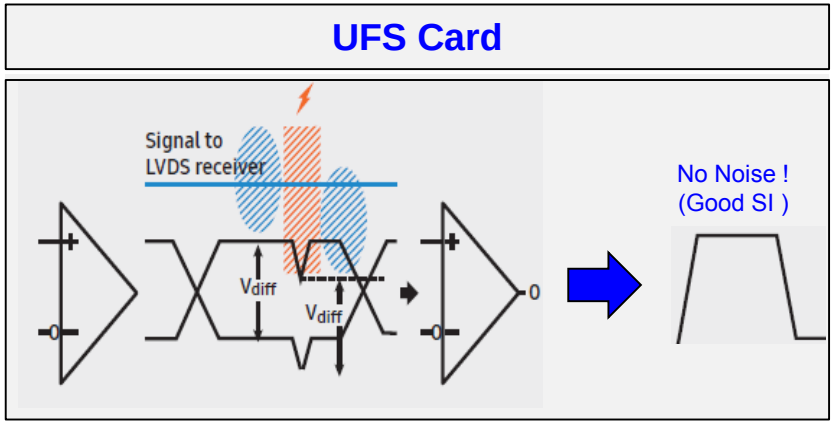
- UFS Card vs. SD Card
  - Tighter RMS Power specification improves Inter-operability
  - Harder Peak Power specification provide better system level Power Stability & Reliability

	SD Card	UFS Card
RMS Power Consumption	**MAX 2.88W in 1,000 msec intervals** ➔ Loose condition draws more power in a shorter time interval, which may lead to system level instability	MAX 1.62W in 100 msec intervals ➔ 10x more strict condition to reduce variation in power consumption between devices. (I.e Improving interoperability) ➔ 1.7x Longer battery life
Peak Power Consumption	Specification does NOT EXIST! ➔ Requires host OEM vendor to assign bigger power budget for covering wide range of peak power for various SD card vendors and their various SD card products	Peak power spec exists as 5 usec intervals ➔ 500mA @3.3v VCC 400mA @1.8v VCCQ ➔ With more strict specification in power consumption for a device to meet, host OEM vendor can safely allocate power budget for PMIC based on this peak power specifications. (I.e Improving System power stability/Reliability)

Reliability -1/3 : Signal Integrity(SI)

- UFS Card vs. SD Card
  - SD signal is affected by outside noise as it is ➔ worse SI
  - UFS signal's differential signal is not affected by outside noise since same amount of noise is applied to both differential signal ➔ Good SI

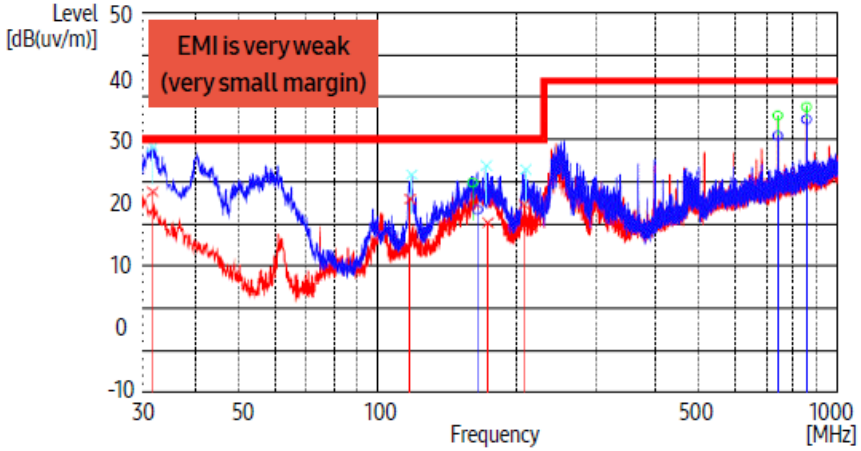




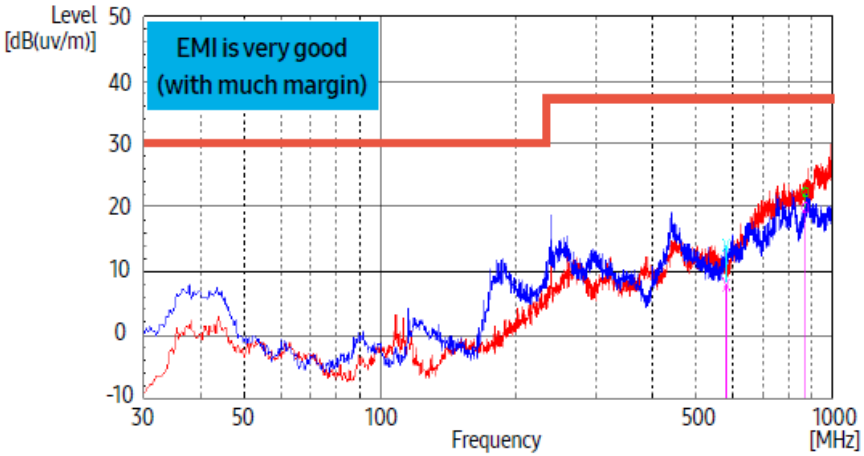
Reliability -2/3 : EMI

- UFS Card vs. SD Card
  - SD Card's pad is very poor in EMI. This results in frequent data losses during daily data storing.
  - UFS Card's state-of-the-art differential pair signaling and reliable PHY/LINK architecture guarantees the good quality of EMI and SI.

SD Card
(satisfying the EMI spec is very difficult, so EMIs are much worse)

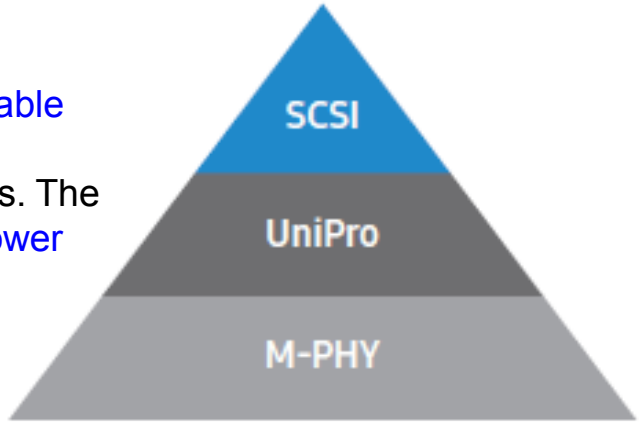


UFS Card
(EMIs for all frequency ranges are below the upper limit of the specification with much margin)



Reliability -3/3 : Architecture level

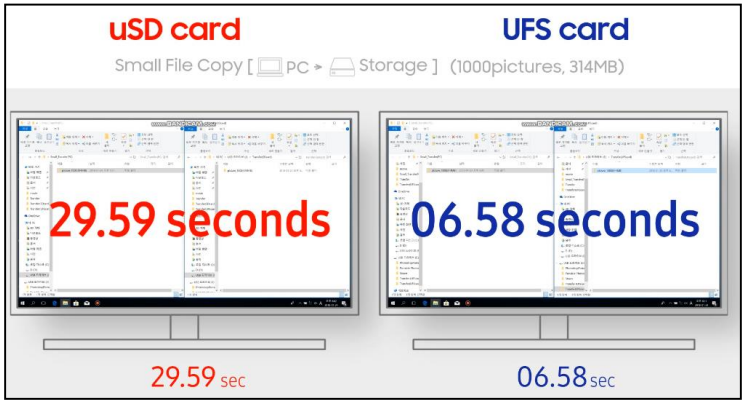
- UFS optimized as for Mobile storage, in low-power, high reliability, stability.
  - SCSI command protocol : evolved in various storage solutions for over 25 years, so systems built on the SCSI command protocol are stable and reliable. SCSI architecture model and advanced command protocols, including command queuing. SCSI is widely used in many storage protocols such as USB3.0, SAS and more.
  - UniPro Link Layer : UniPro provides detection and recovery from I/O errors on the hardware layers without requiring restarting from the host.
  - M-PHY Physical Layer : providing ultra-high bandwidth and reliable data transmission, specifically developed for the high-demand performance and low power requirements of mobile applications. The interface offers a low active power level and a near-zero idle power level for noteworthy reductions in device power consumption.

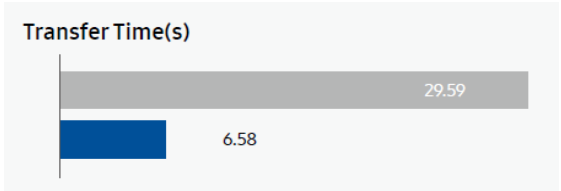


Measurement in same HW environments

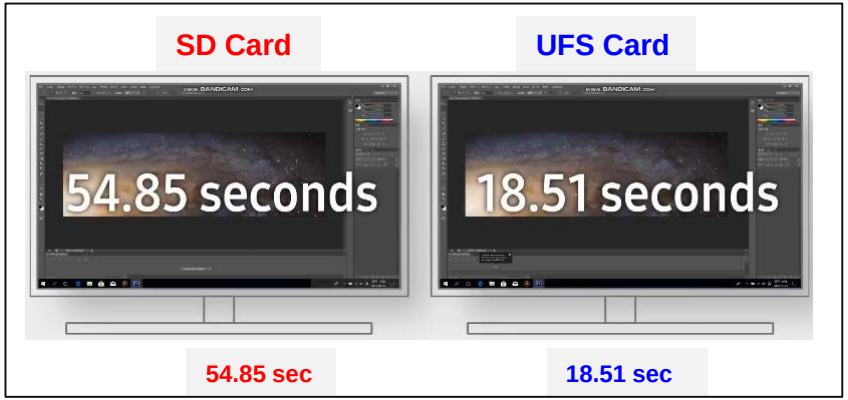
- UFS Card showed superior performance in real user scenarios.

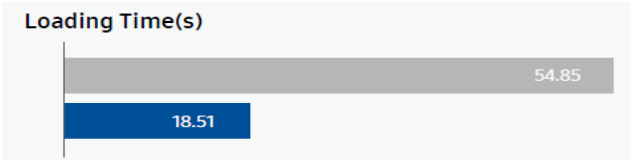
(Test-#1) Transferring 1,000 photo files.
The UFS Card shows 4.5x times faster completion which improving UX a lots. (Random Write related User Scenario)





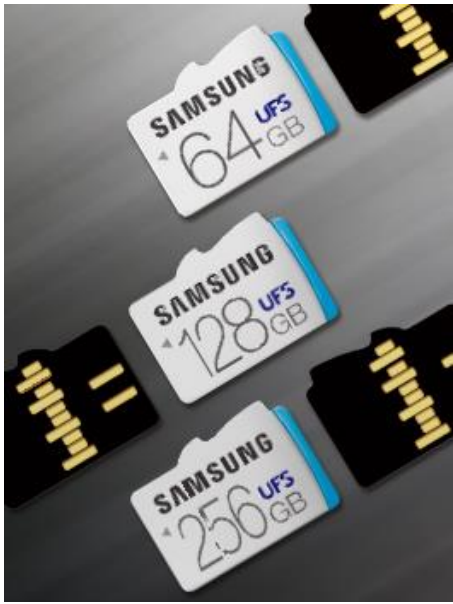
(Test-#2) The 4GB Adobe Photoshop loading time measurement. The UFS card shows 3.0x times faster completion. (Seq. Read related User Scenario)





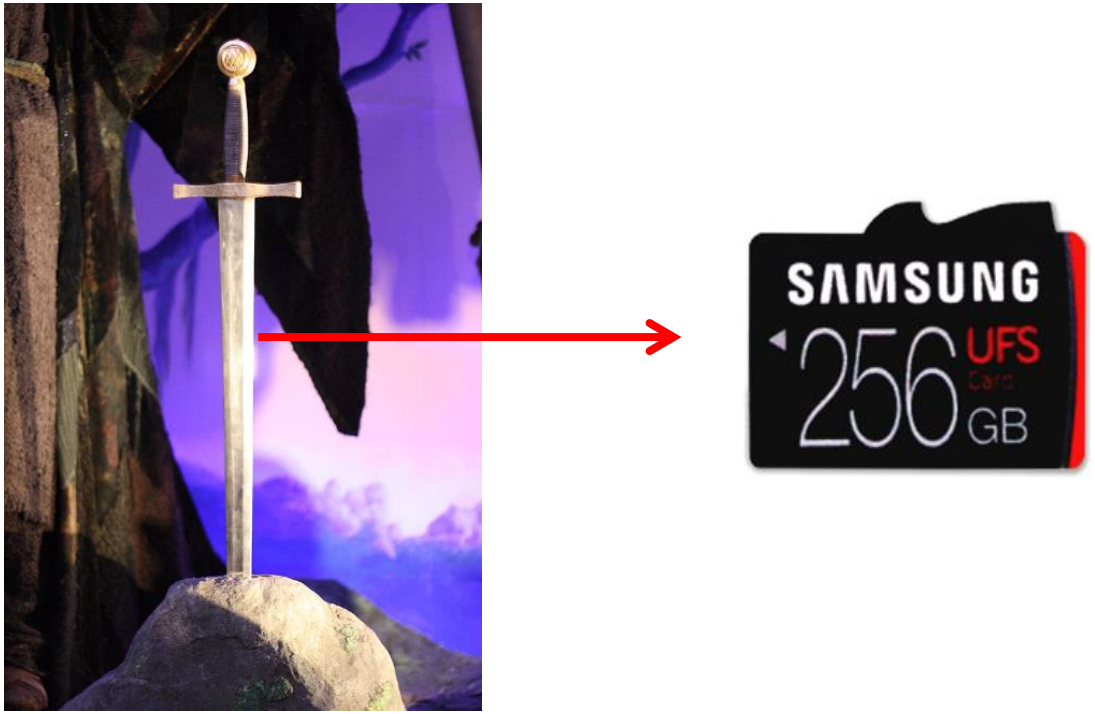
Conclusion : New Era of UFS Card as for external storage

- Superior performance/Low Power/Reliability replacing legacy SD Card
  - 5x times higher Seq. Read/ 70x times higher Random Write Performance
  - Lower Power Consumption
  - Higher Data Reliability
- from advanced UFS Card Architecture
  - Parallel read and write operations, queuing and out of order execution the mixed and interleaved data transfers to maximize performance
  - Applications are not blocked by I/O of other applications,
  - Physical/Link layer which optimized for lower power/ high reliability etc.
- Therefore, ideal for 5G, AI, Automotive as well as Multi-processing environments, including nowadays Linux OS, Android OS, Window OS, and Apple iOS, which are used in most Smart-Phones and Tablets, as well as VR, AR, DRON, DSLR and other IT devices.



Winner takes it all

- A Legend of England … King Arthur obtained the British throne by pulling a sword, Excalibur, from a stone…



- Any Questions ?

(Title) Practical Solution to build UFS Card supporting Host system

	Robert Hsieh leads mobile embedded product marketing at Silicon Motion, where he does strategic product planning and OEM project management for mobile embedded products. He has managed to mass production eMMC/UFS controllers for the company and has successfully designed in key OEM customers. He has more than 15-year experience in storage product design and mobile product marketing. He is a USFA Board Member and has presented at past Flash Memory Summits.
Robert Hsieh @ SMI, Marketing director, robert.hsieh@siliconmotion.com	SMI will give an introduction to explain how SMI support the UFS Ecosystem to make UFS and UFS card easier to be adopted in industry, especially for host vendor who want to adopt UFS card in their mobile & IT products.

Practical Solution to build UFS Card

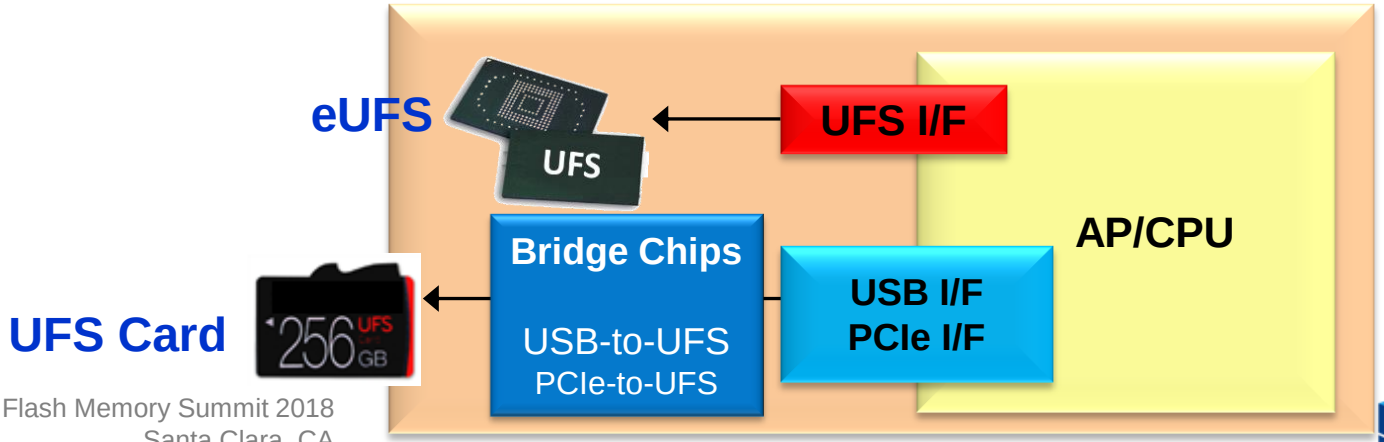
Supporting Host System

Robert Hsieh

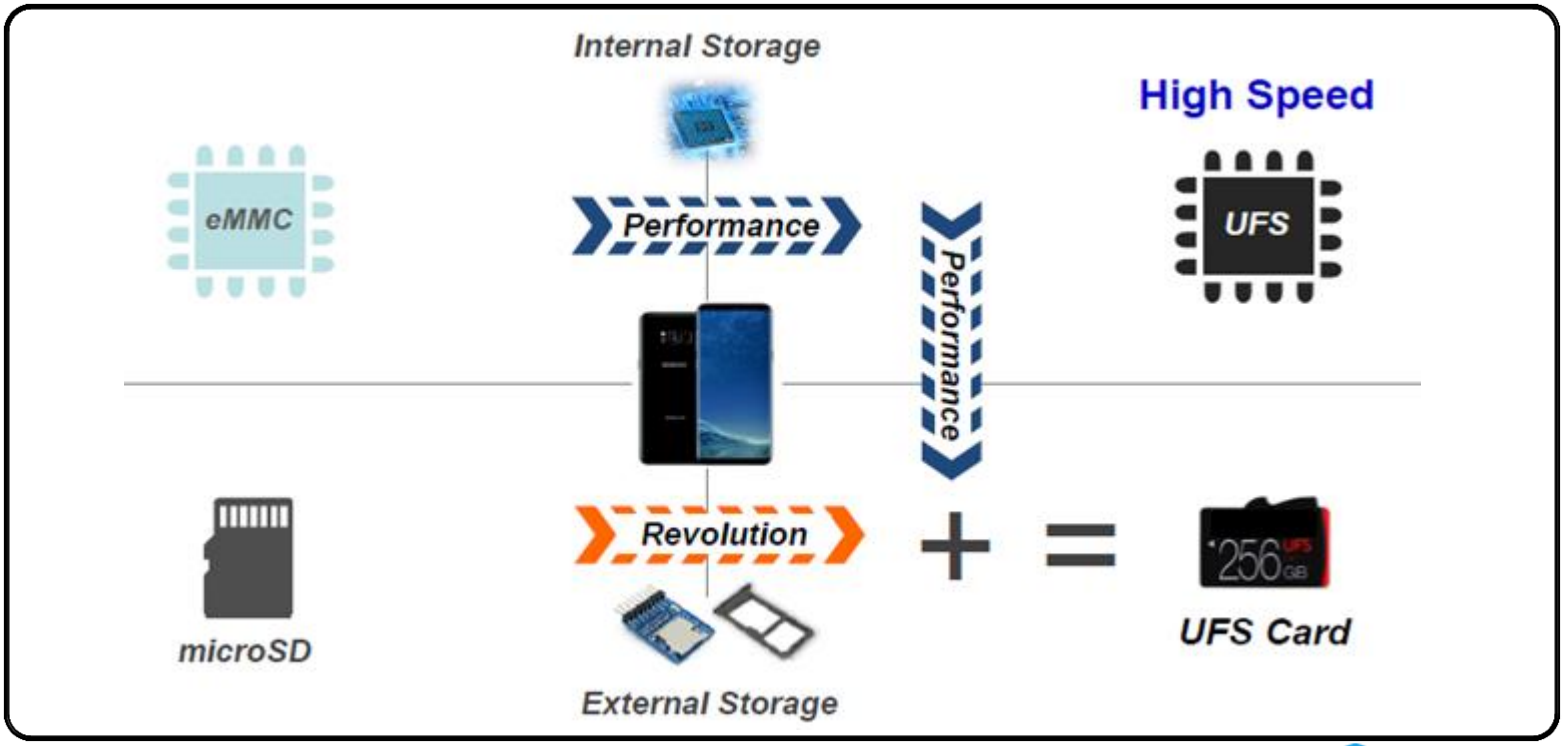
Silicon Motion, Inc.

- **Applications**
  - Existing platforms
  - New applications

- **Manufacturing**
  - Legacy tool can't support UFS
  - Reasonable Cost

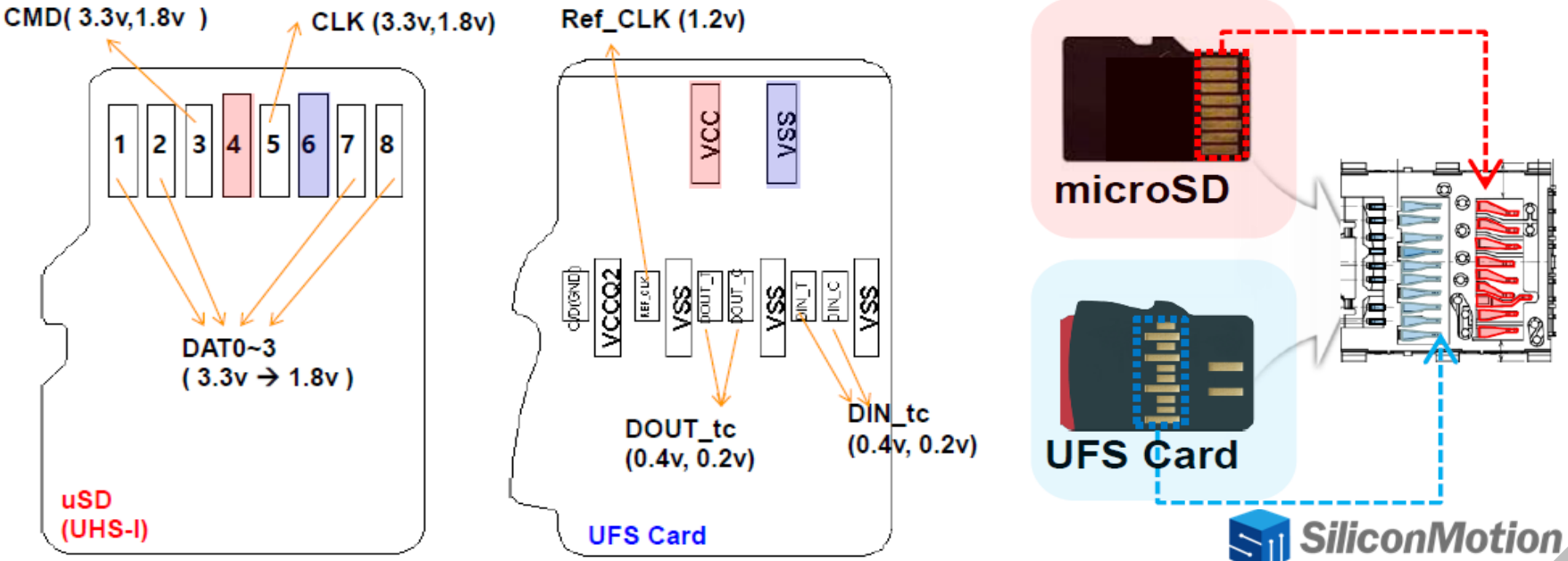


UFS Card – High Speed External Card

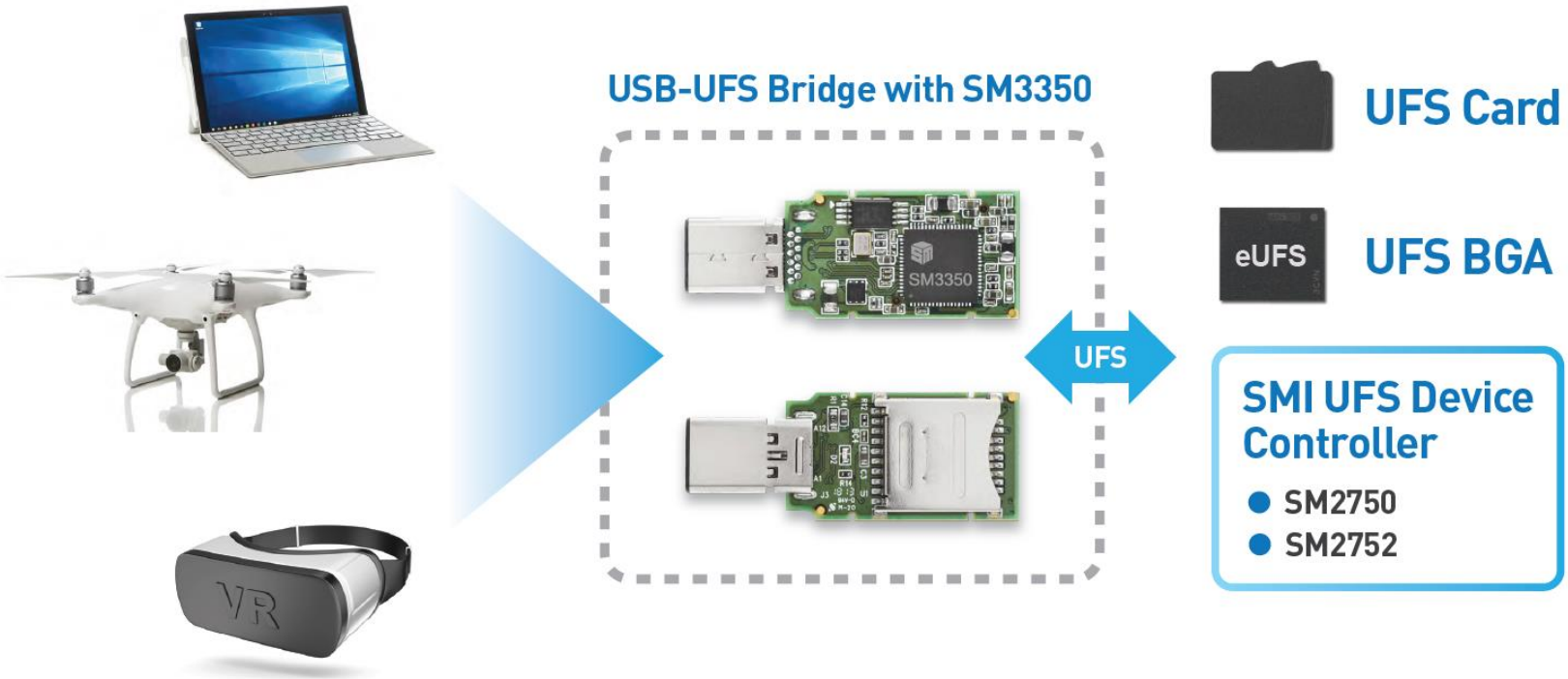


UFS Card – Low Power Architecture

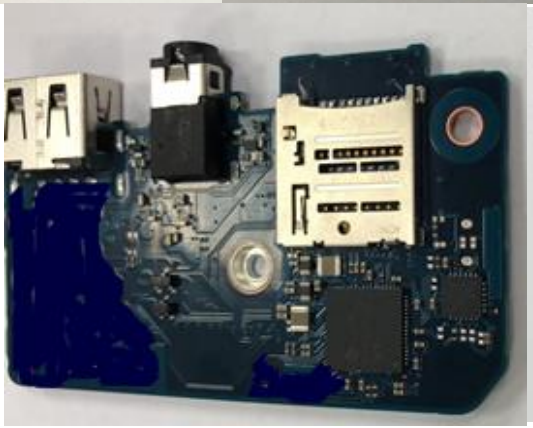
- **Legacy Card – Starting with 3.3V; after initialization, voltage going to 1.8V**
- **UFS Card – Data line(DIN, DOUT) running in 0.4V ~ 0.2V**

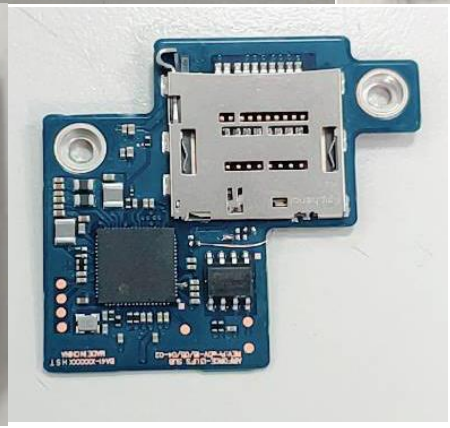


SMI UFS Controller Ecosystem



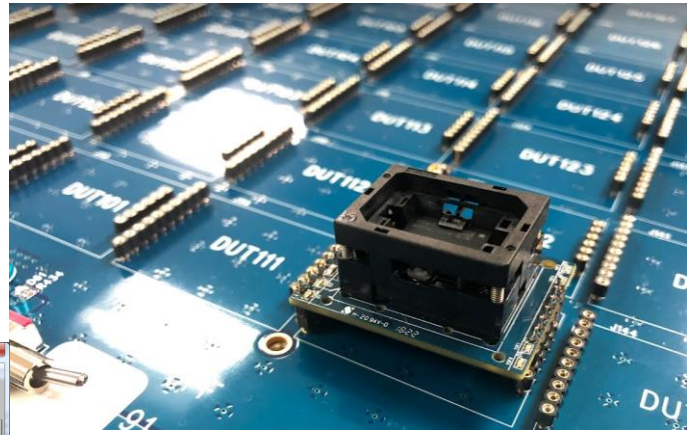
USB-UFS Bridge Product Design-In

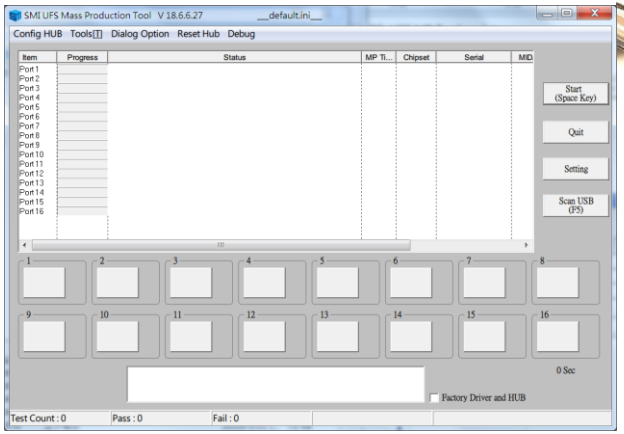




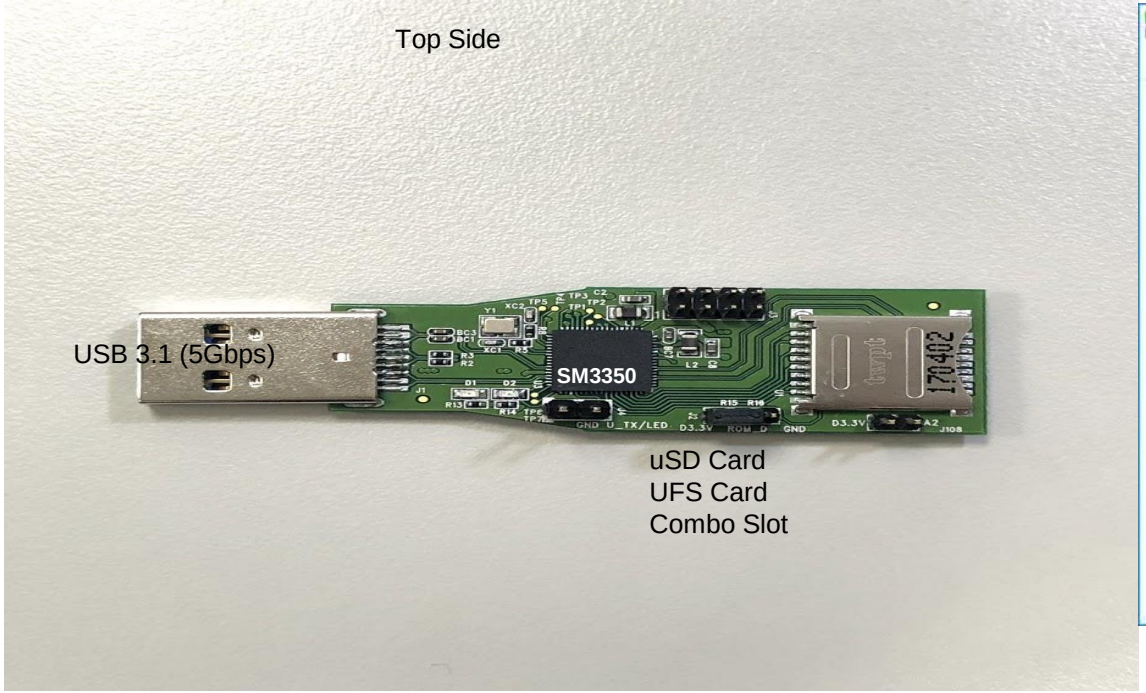
USB-UFS Bridge - Make UFS Ecosystem

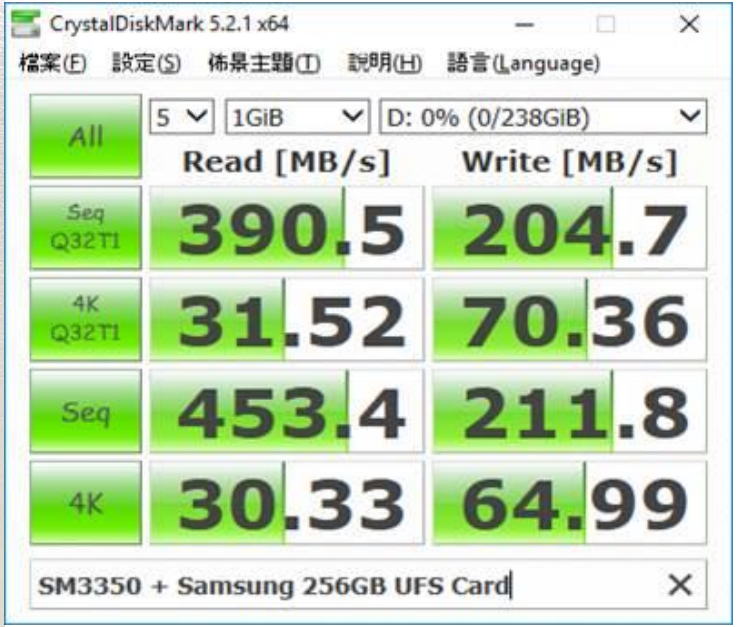
- Easier Manufacturing
  - MP Tool Tester
  - MP Tool Software
  - Burn-in Board





USB-UFS Bridge + UFS Card – Superior Performance





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- **Choose the Good Partner -**
  Make your UFS Products Visible

Thank you

robert.hsieh@siliconmotion.com

SiliconMotion

(Title) UFS for data center usages

	Lee Prewitt is a Principal Program Manager with 25 years of storage industry experience ranging from Magneto-Optical to spinning rust to FLASH. He currently works in the Windows and Devices Group at Microsoft where he is responsible for many of the components in the storage stack including File Systems, Spaces, Storport and Microsoft's inbox miniport drivers. He is responsible for storage devices ranging from SD and UFS in mobile to NVMe in Enterprise and Data Centers. He is also the Microsoft representative to the UFSA Board.
Lee Prewitt, Principle Program Manager , leprewit@microsoft.com	Learn about Microsoft's support for UFS in Data center

UFS Data Center Use Cases

Lee Prewitt
Principle Hardware Program Manager
Microsoft

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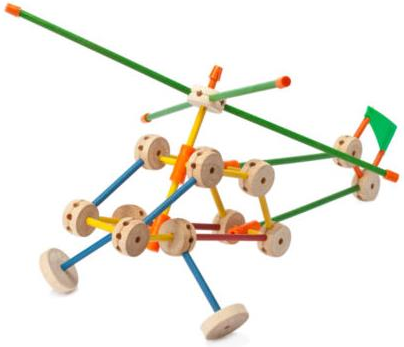
The Challenge



- Dynamic time for NVM in the modern Datacenter
  - Flash proliferation in compute and storage (JBOD->JBOF)
  - PCIe – Transitioning from Gen3 to Gen4. Gen5 coming!
  - New storage technologies are challenging NAND

- Existing form factors are constrained
  - Rotating media form factors constrain density
  - Lack of hot plug support constrains serviceability
  - Divergence of FFs constrains system flexibility

Adapting existing early "tinker toy" form factors will only take your Datacenter so far …

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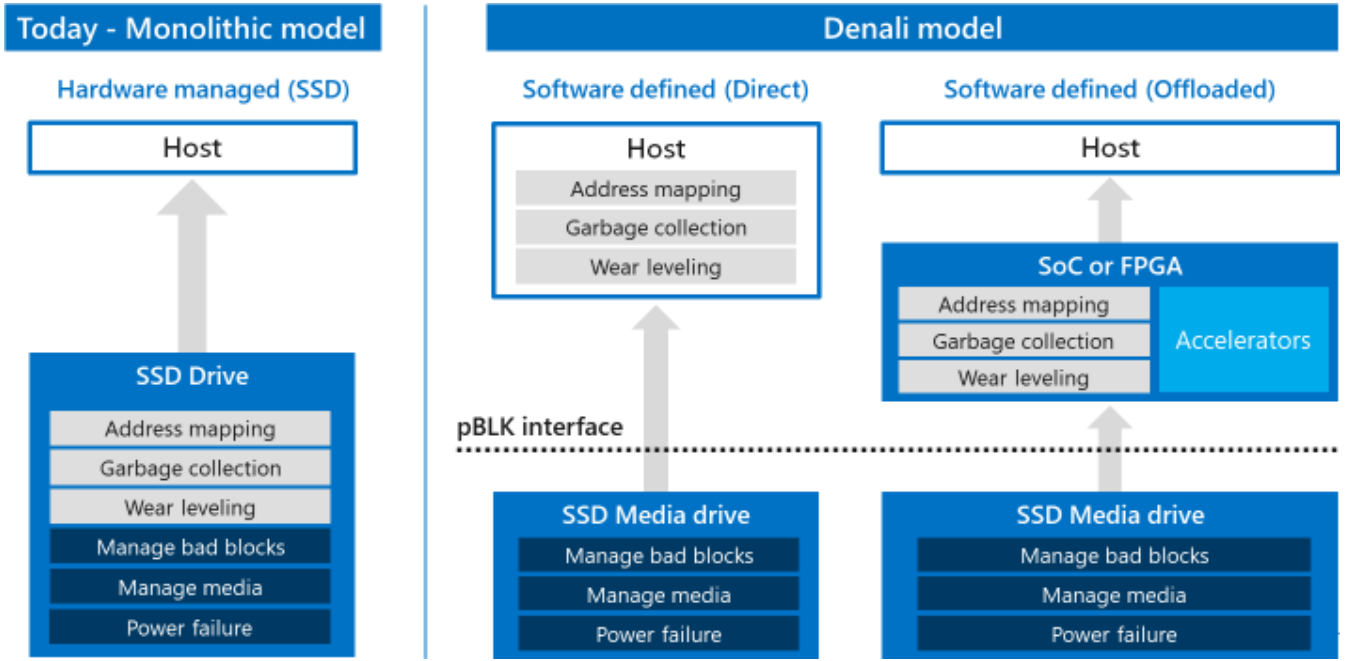
Disaggregating Flash for the Datacenter



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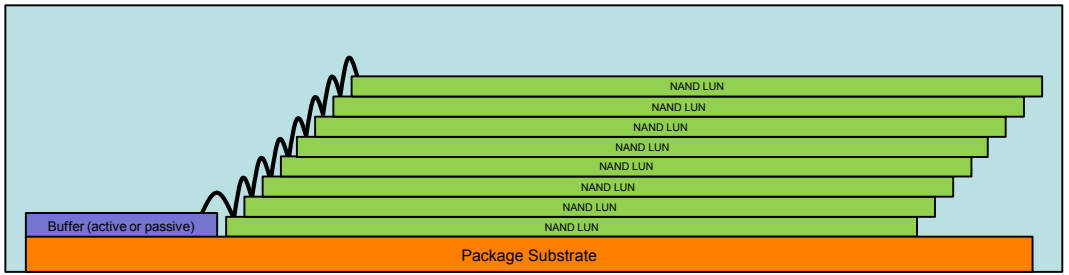
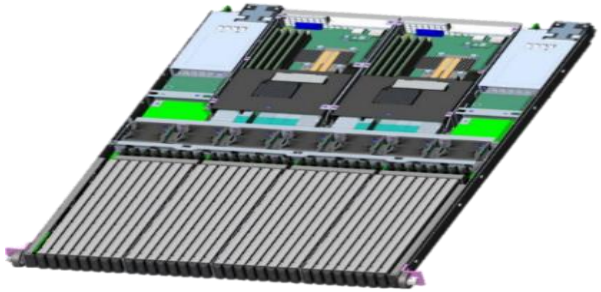
Cost-effective Media SSD

- All high-stack NAND requires buffering
- Serialization limits bandwidth
- NVMe/PCIe high overhead challenges
  - DMA programing
  - PCIe Root Complex



SFF–TA1007: Optimized for Storage

- System-optimized for 1U server
  - Vertical 1U support, Scalable to 2U
  - UP to 48 NVM sites
- Key Benefits:
  - *Maximum density*
  - *Optimal cooling*
  - *Hot Plug Support*
  - *Scalable Growth*



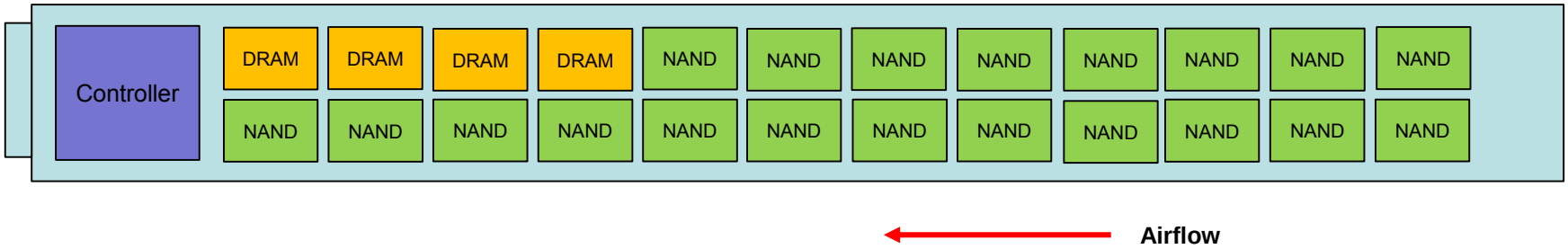
Dimensions	Millimeters	Tolerance	Comment
B1	38.4	0.25	Device width
C1	318.5	0.35	Device length

Enable the ultimate NVM density in 1U. 1PB in 1U and beyond.

SFF–TA1007: Optimized for Storage

- Roughly 120cm^2 of board area per side
  - What can we do with that space?

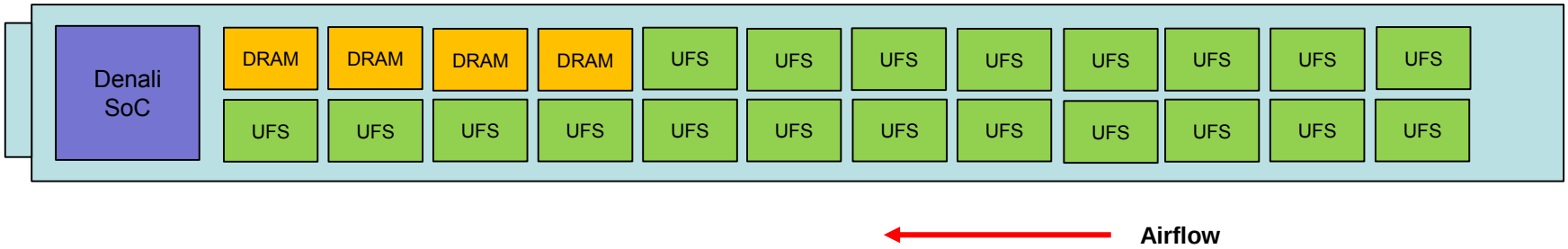
- Today we have a traditional storage device



Enable the ultimate NVM density in 1U. 1PB in 1U and beyond.

Leveraging Commodity SSDs for the Datacenter

- But we don't have to…
  - Bring portions of the workload down close to the storage media
  - Offload of common functions (Compression, Encryption, etc.)
  - Use a low power, high speed, point to point link between the Denali SoC and the storage media (MIPI)



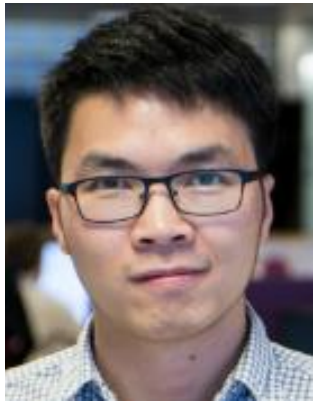
Thinking inside the box. UFS as a lightweight bus.

Conclusions

- Optimize NVM for DC use cases
  - Optimized solution *for that system* including cost, airflow, and capacity
  - Enable innovation through upcoming technology disruptions
  - Move the intelligence closer to/farther from the storage as needed

Don't be afraid to question your storage assumptions

(Title) Optimizing for hardware: how to maintain storage performance in the long-run

	Yongjun currently works as business development director at Tuxera. His experience covers new market entry, new customer development and strategic partnerships, particularly in consumer electronics and automotive segments. Yongjun also represents Tuxera in various industrial standard organizations including JEDEC and UFSA. Originally from China, Yongjun moved to Finland in 2011 and started working at Tuxera since 2013. He holds a MSc degree from Aalto University (Finland).
Yongjun Zou, Business Development Director, zou@tuxera.com	Optimizing for hardware; how to maintain storage performance in the long run

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UFSA

Optimizing for hardware

how to maintain storage performance in the long run

Yongjun Zou

Business Development Director at Tuxera

TUXERA


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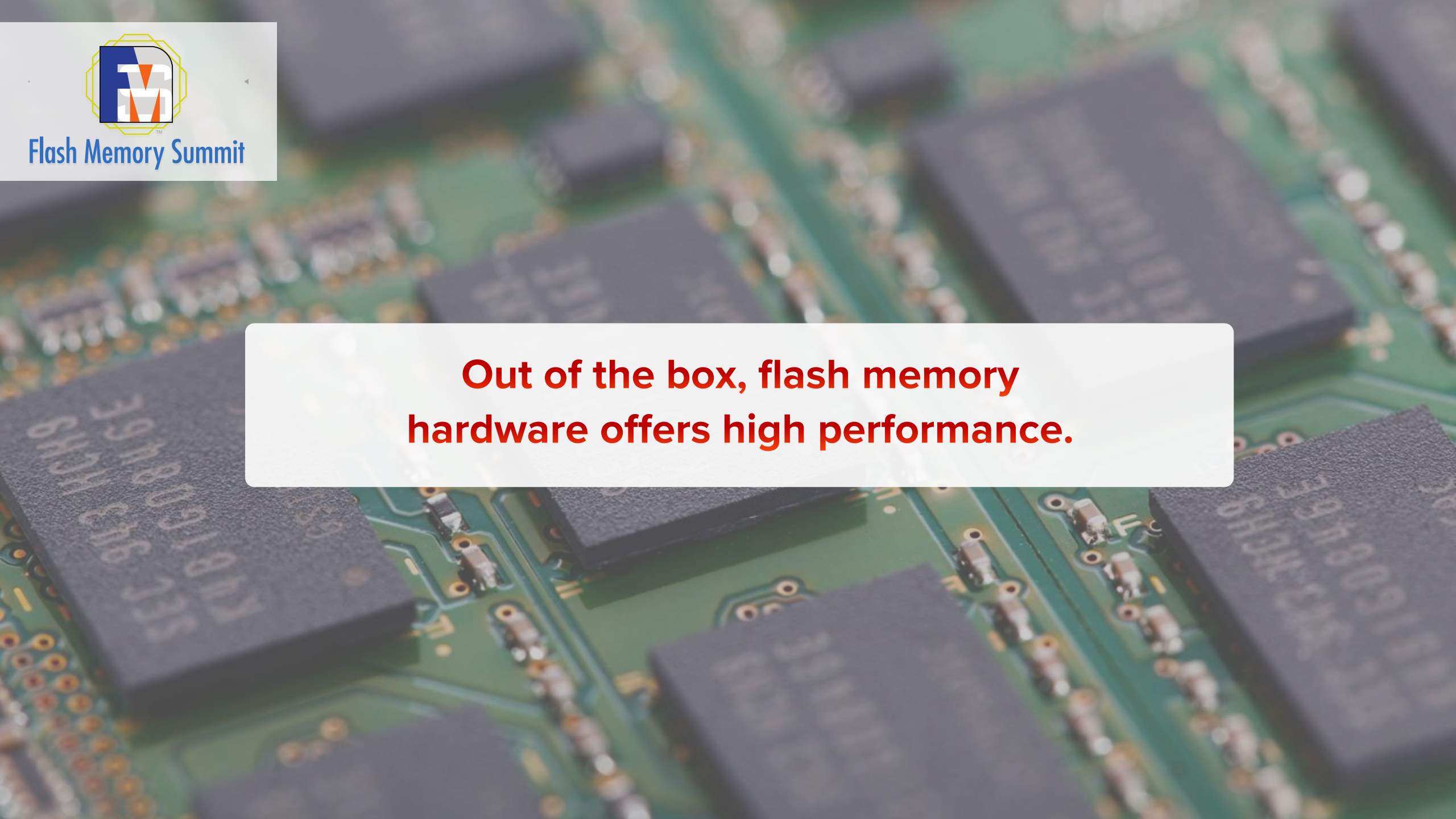
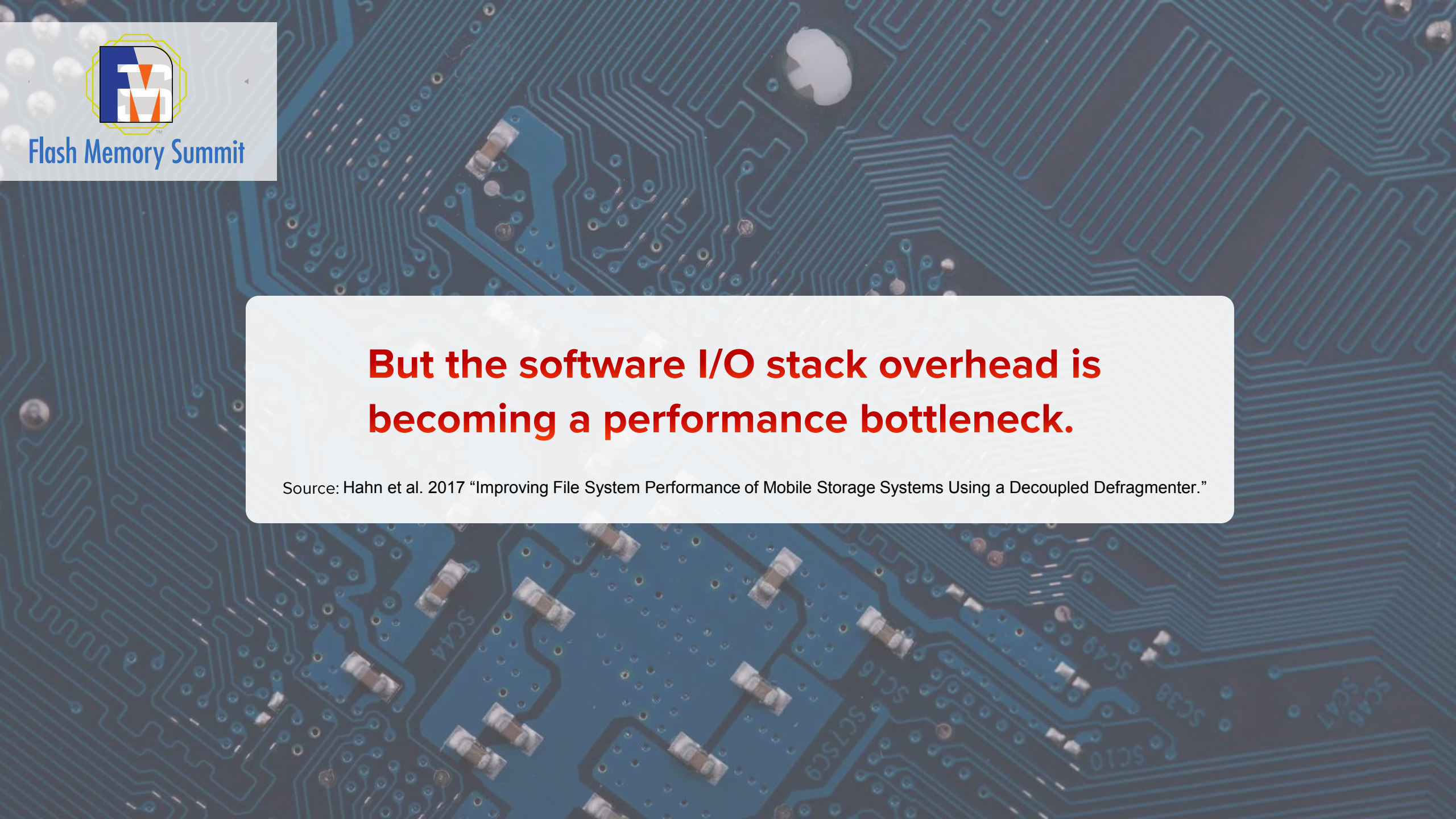
12:26
Universal Flash Storage
Can be applied in multiple use-cases



Out of the box, flash memory hardware offers high performance.



But the software I/O stack overhead is becoming a performance bottleneck.

Source: Hahn et al. 2017 “Improving File System Performance of Mobile Storage Systems Using a Decoupled Defragmenter.”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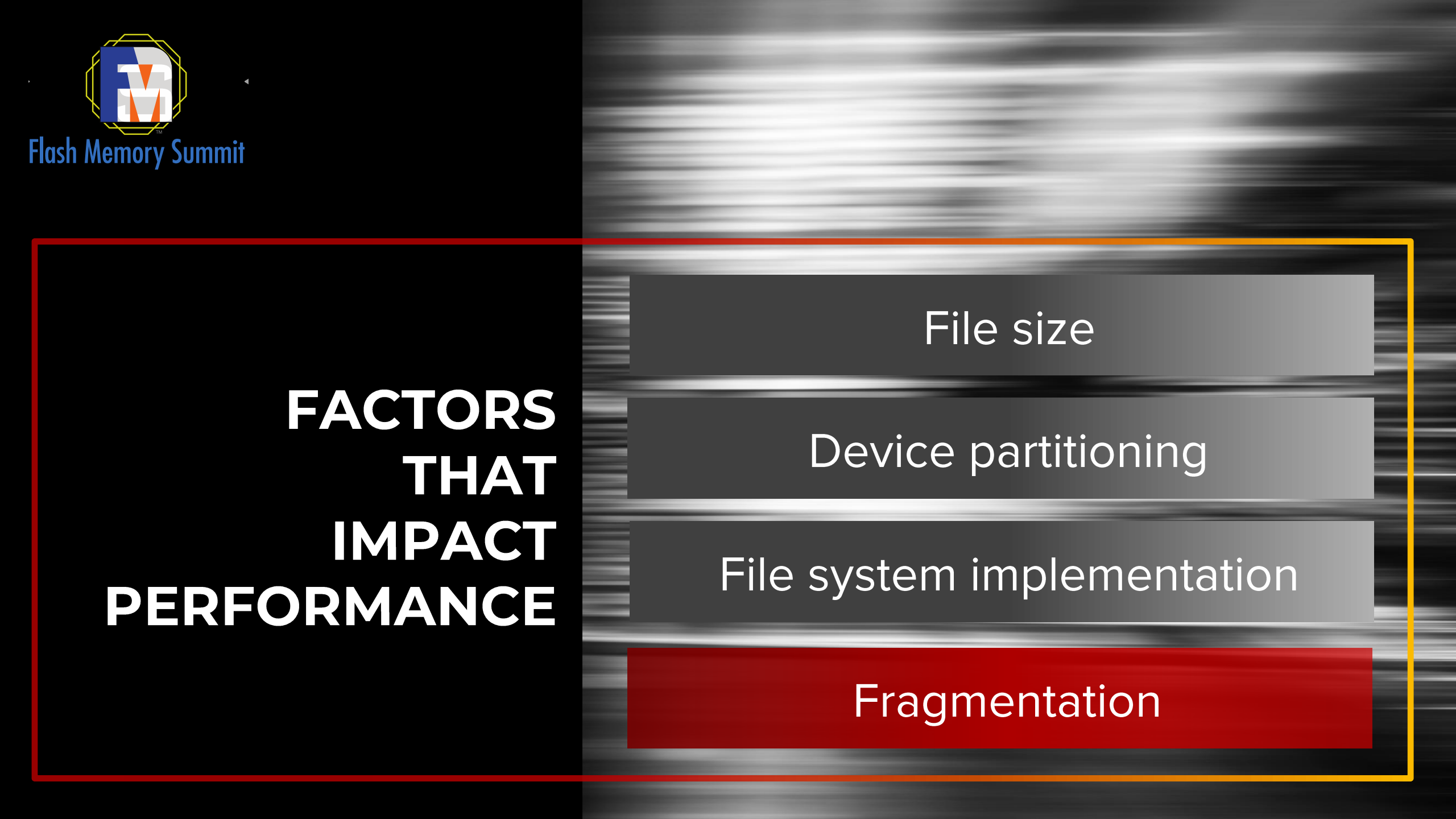
FILE SYSTEMS AFFECT:
Read/write performance
Data integrity
Flash endurance
Fragmentation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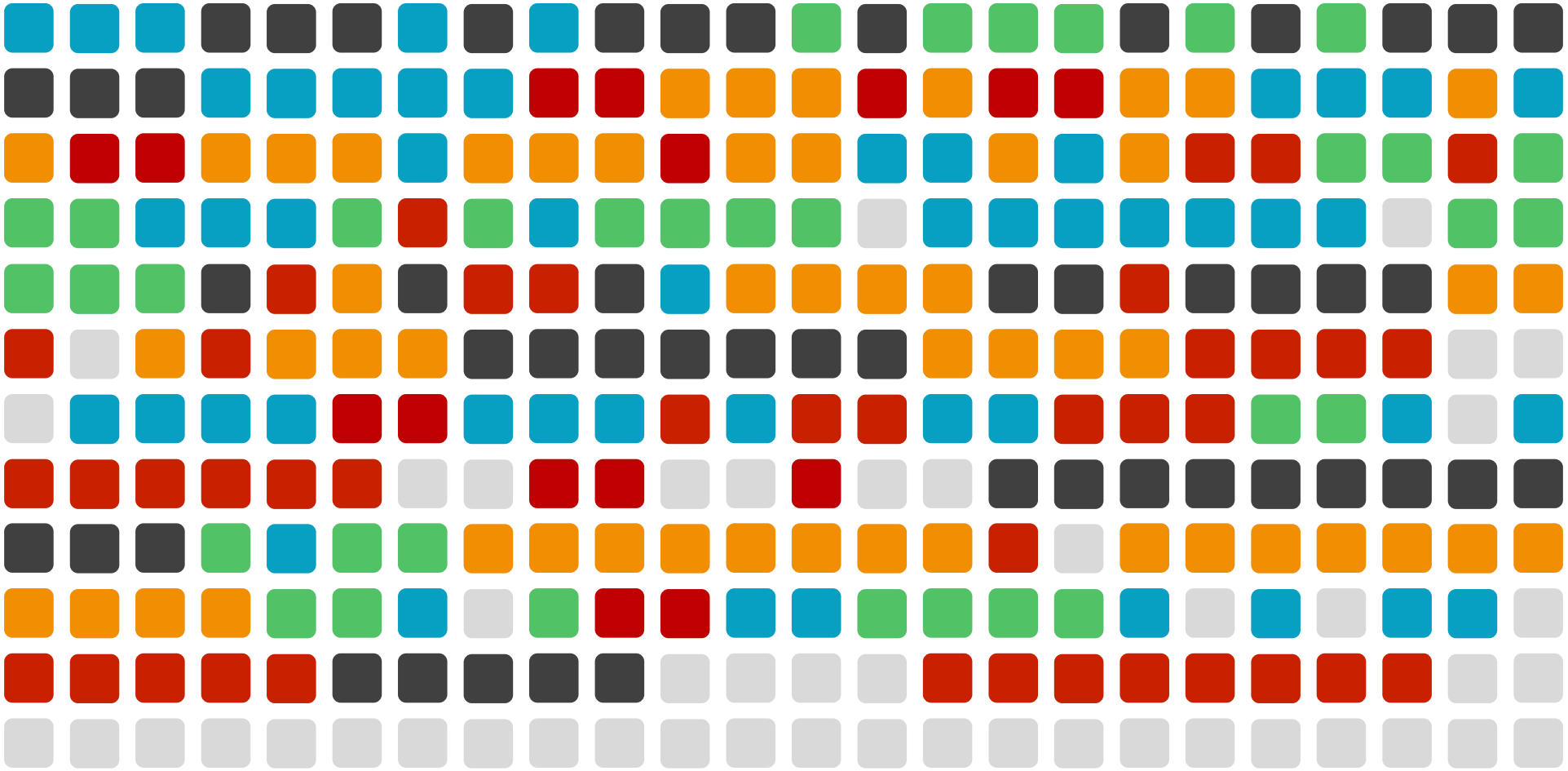
FACTORS THAT IMPACT PERFORMANCE
File size
Device partitioning
File system implementation
Fragmentation

Fragmentation happens when a file system lays out files in non-contiguous parts, or fragments.



For years, fragmentation was considered “just a mechanical problem.”

Fragmentation is a first-order performance issue—even on modern flash technology.

Source: Conway et al. 2017 “File Systems Fated for Senescence? Nonsense, Says Science!”

IMPACTS OF A FRAGMENTED FILE SYSTEM

(mobile phone studies)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2–5x
performance slowdown
Aging happens so rapidly it's built into user expectations.
Conway et al. 2017

1.6–2x

longer app launch time

Rapid degradation as file system fills: within 7 days of defragmentation.

Hahn et al. 2017

I/O frequency increases

read performance drops

I/O latency is proportional to degree of fragmentation.

Ji et al. 2016

Early storage failure

Defragmenting the storage to ensure user satisfaction could reduce lifetime up to 10%

Hahn et al. 2017

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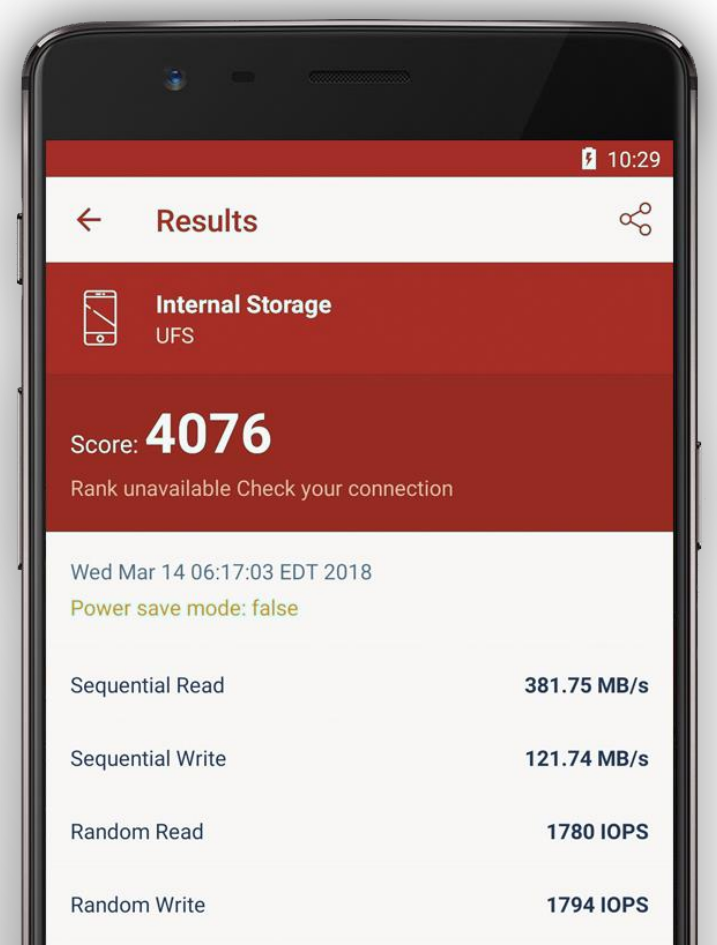
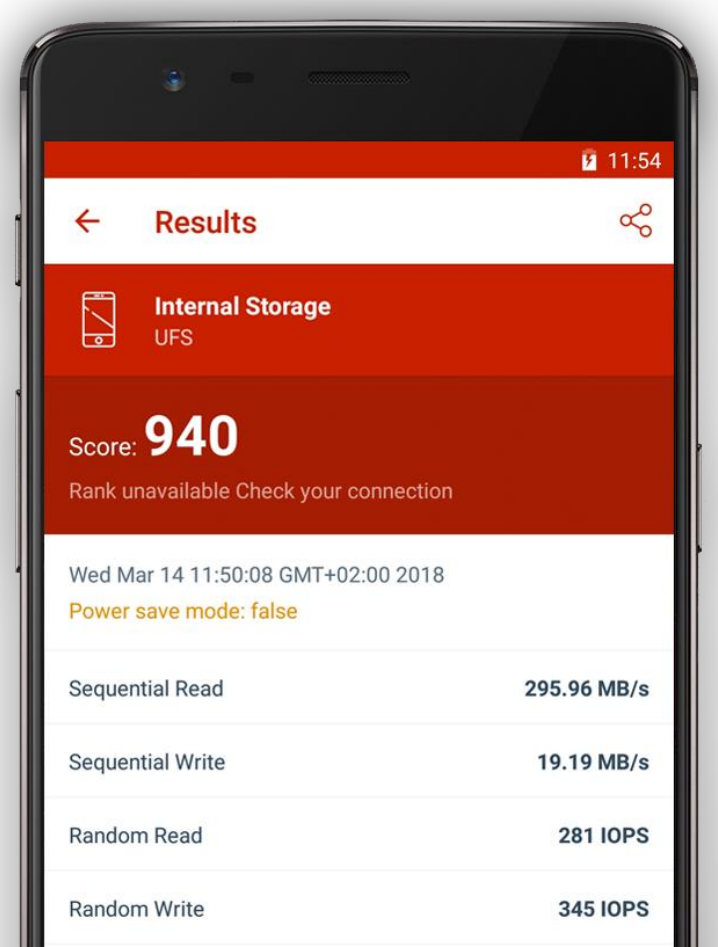
Storage performance degradation on OnePlus 3T

Out of the box



1 year of use



Up to

5 times

degraded

performance

Based on the featured OnePlus 3T (**64GB UFS 2.0**) benchmarking results

In most cases, open-source file systems are used in the consumer electronics industry.

- open-source, free
- good for low data, single-stream use cases*

*Modern CE applications rarely have a single-threaded data stream, however.

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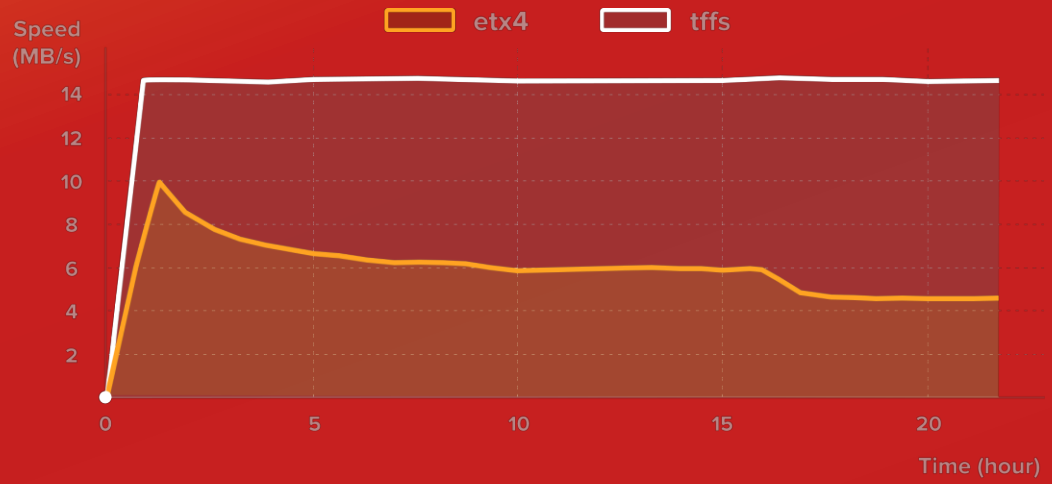
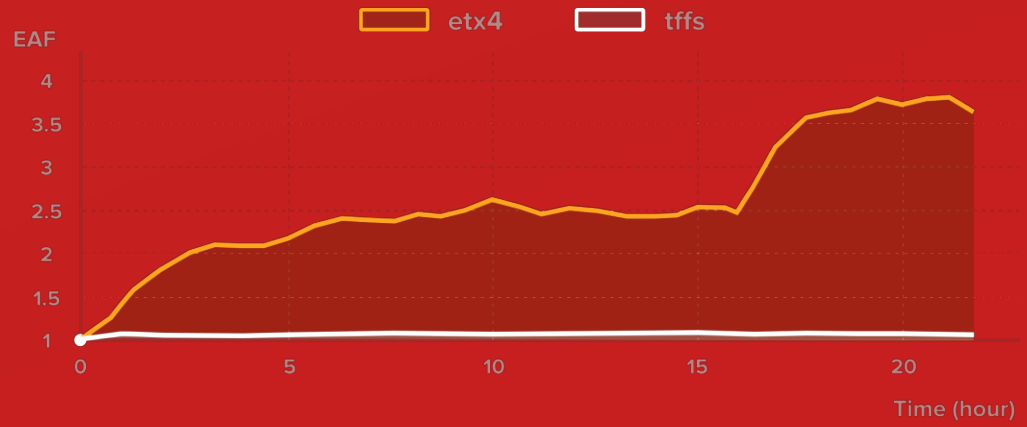
Over the long term:

- ext4 performance drops
- erase amplification increases
- ext4 fragmentation gets worse





Test setup: Ambarella S2 A2 RH with external flash storage

FRAGMENTATION
DEMO

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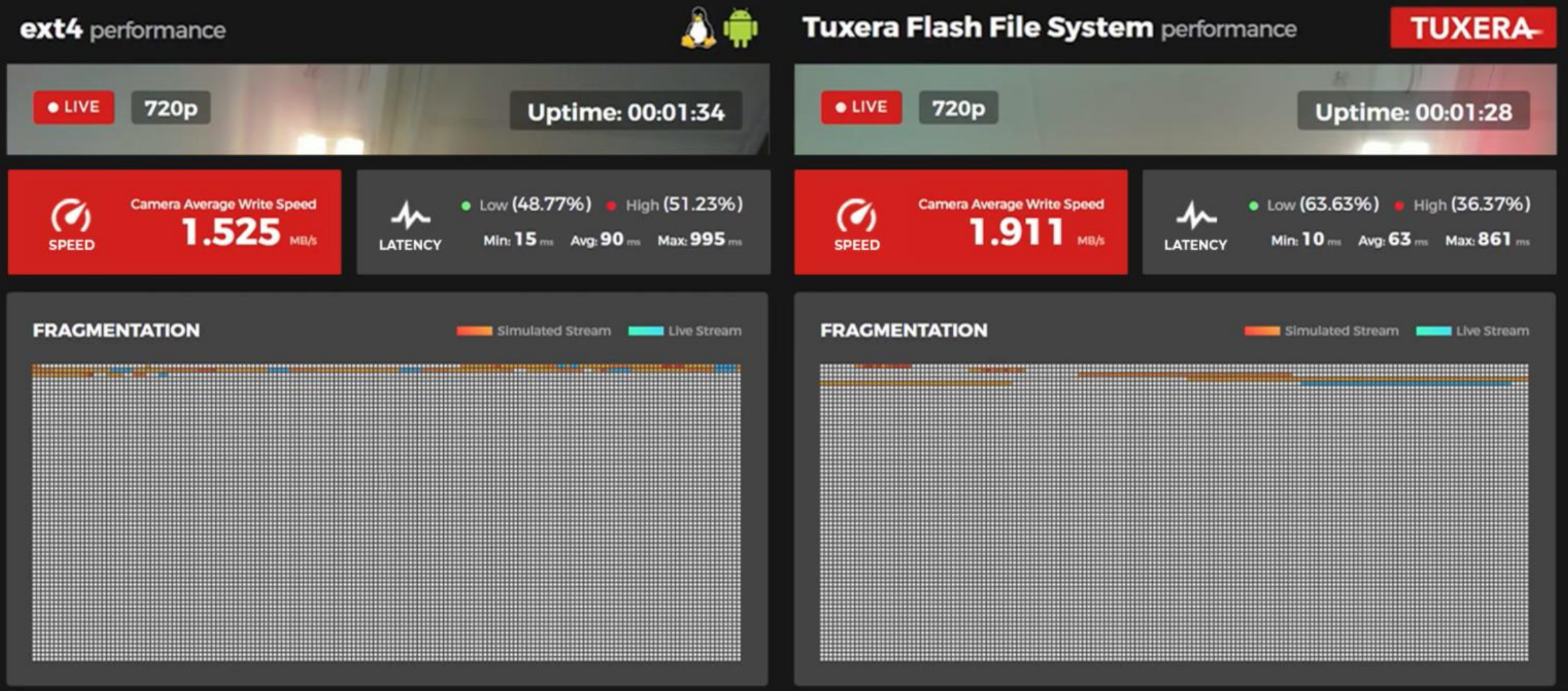
Initial performance



16 GB external flash storage running on Nvidia Jetson TK1

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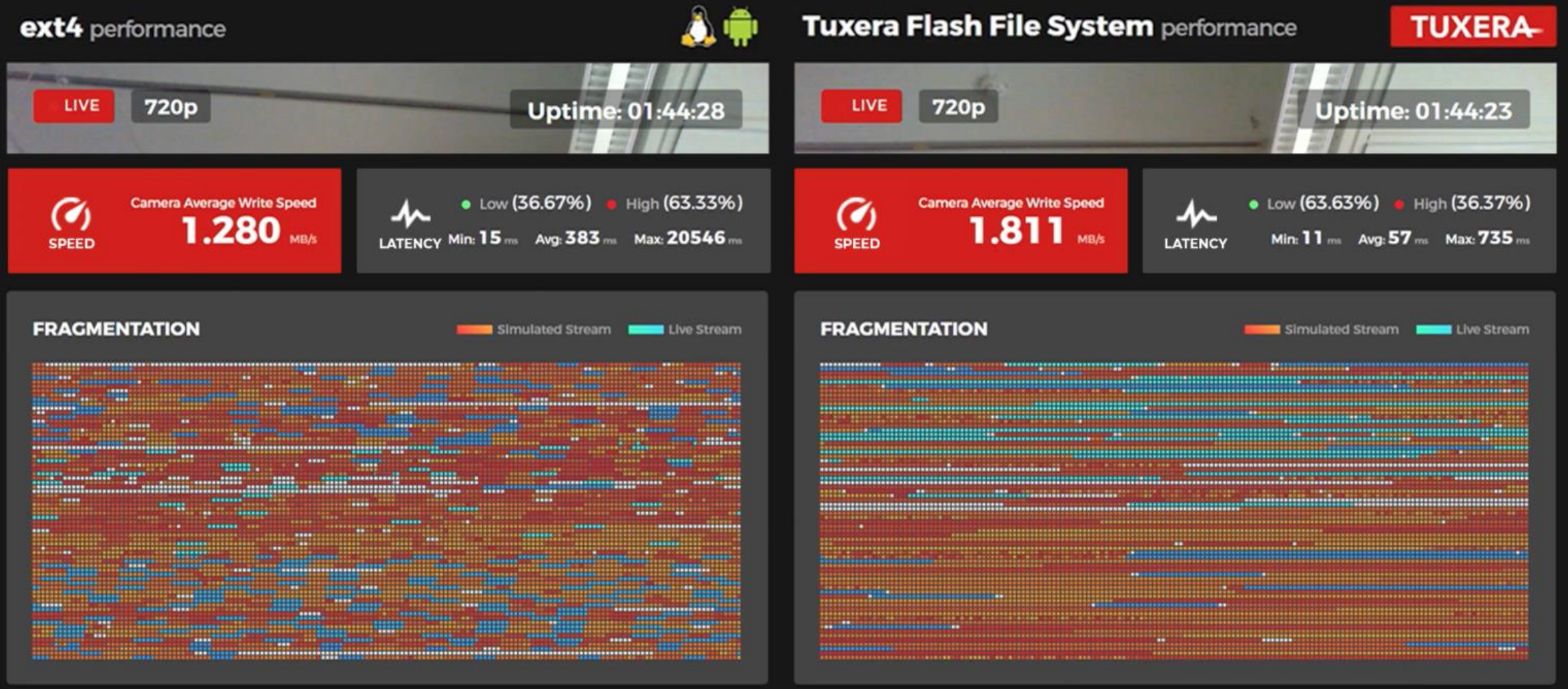
Storage near capacity



16 GB external flash storage running on Nvidia Jetson TK1

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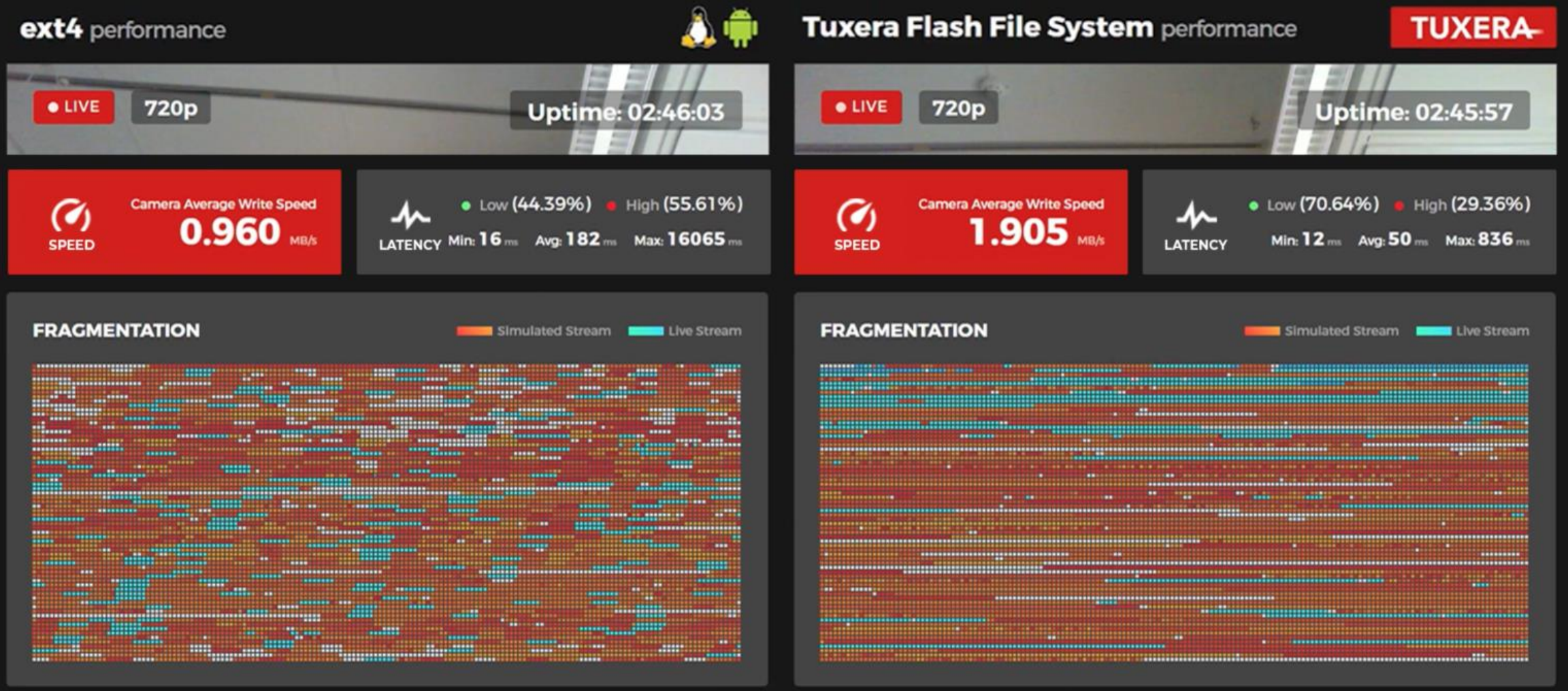
Performance under long-term workload



16 GB external flash storage running on Nvidia Jetson TK1

Out of the box open source

- becomes rapidly fragmented
- speed decreases
- latency increases
- very sharp latency spikes

Optimized for hardware and the use-case

- longer, more contiguous sequences
- maintains higher speeds
- consistently low latency

POTENTIAL IMPACTS OF FRAGMENTATION

in Consumer Electronics

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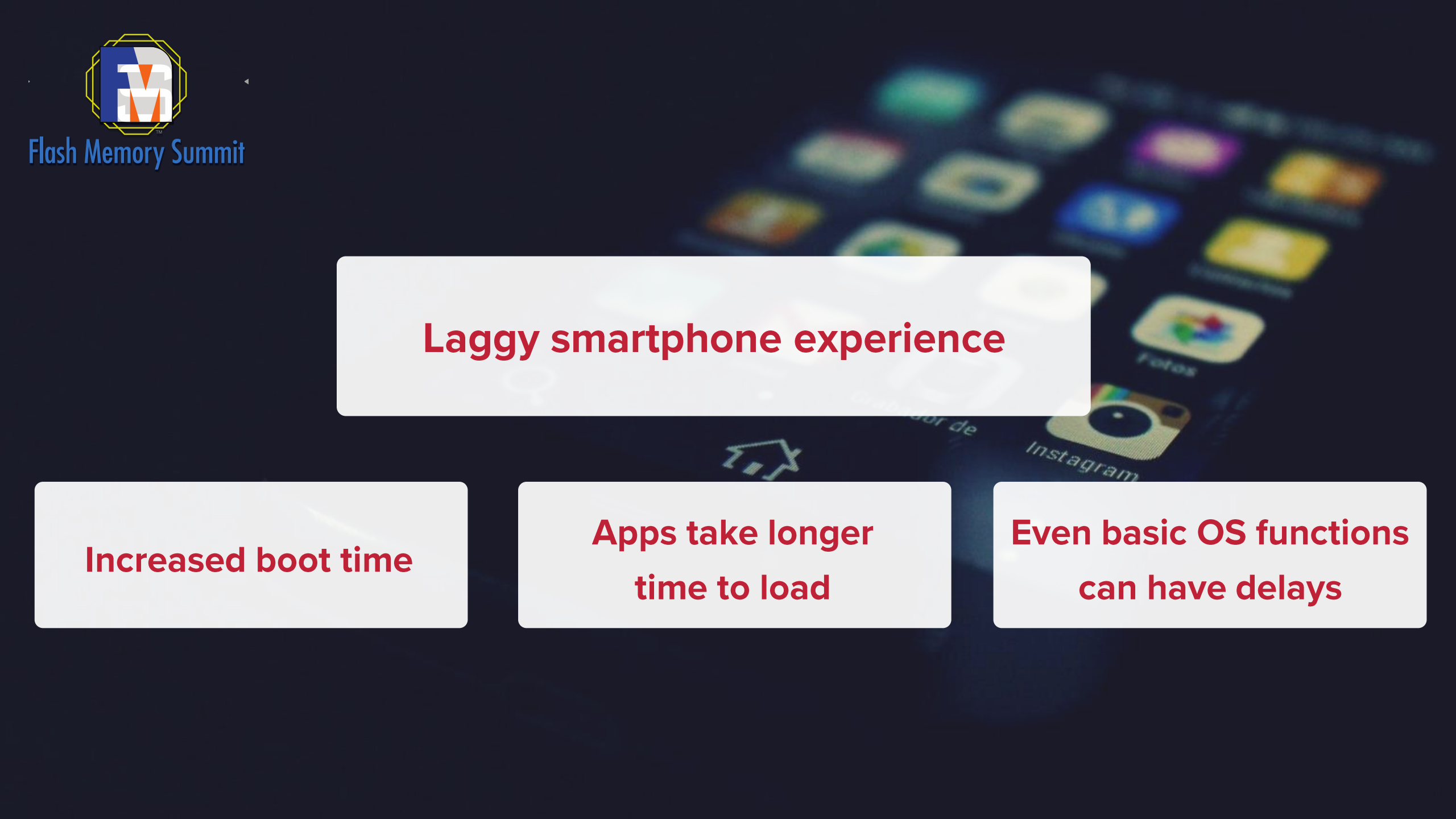

Laggy smartphone experience

- Increased boot time
- Apps take longer time to load
- Even basic OS functions can have delays


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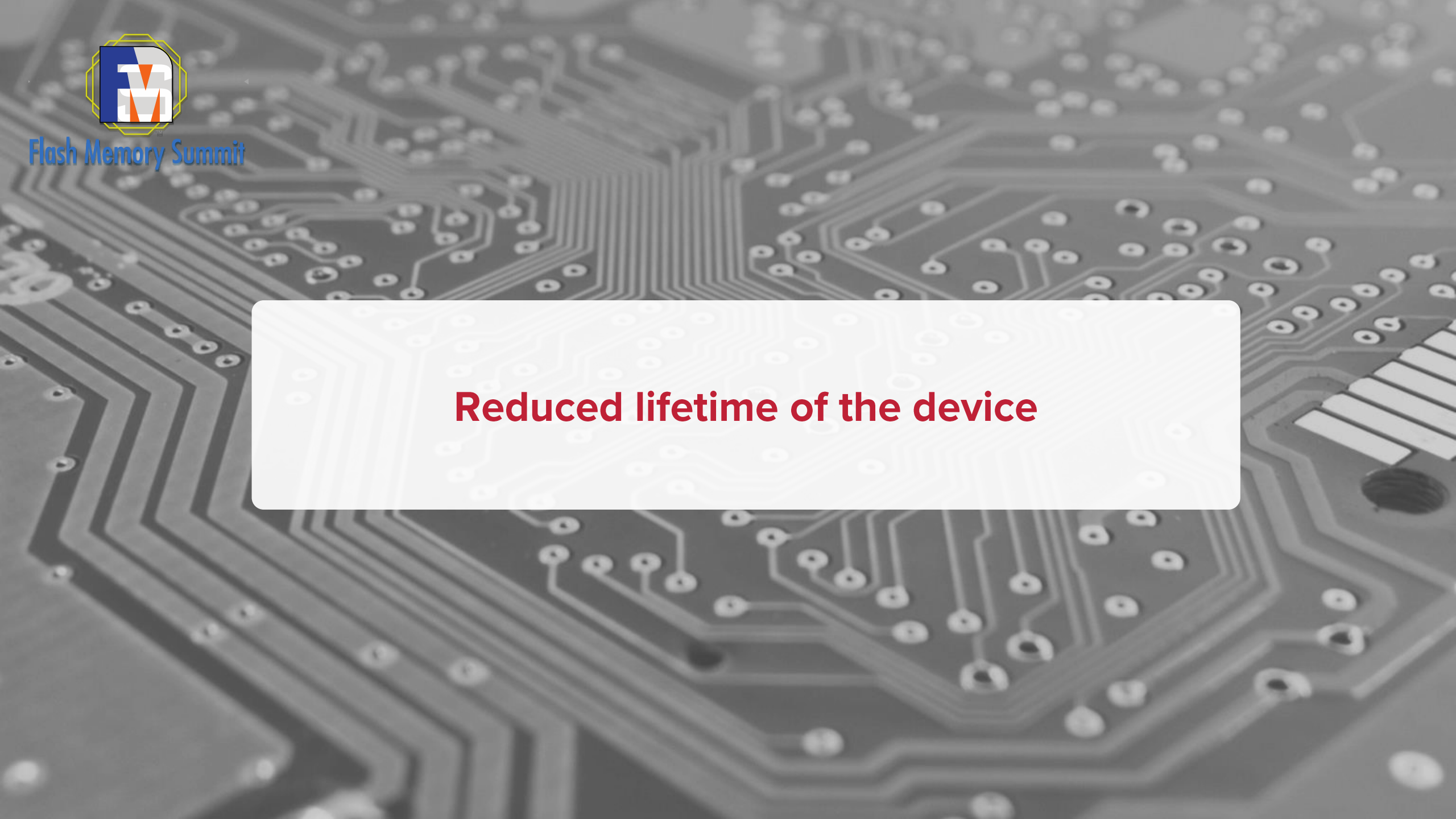
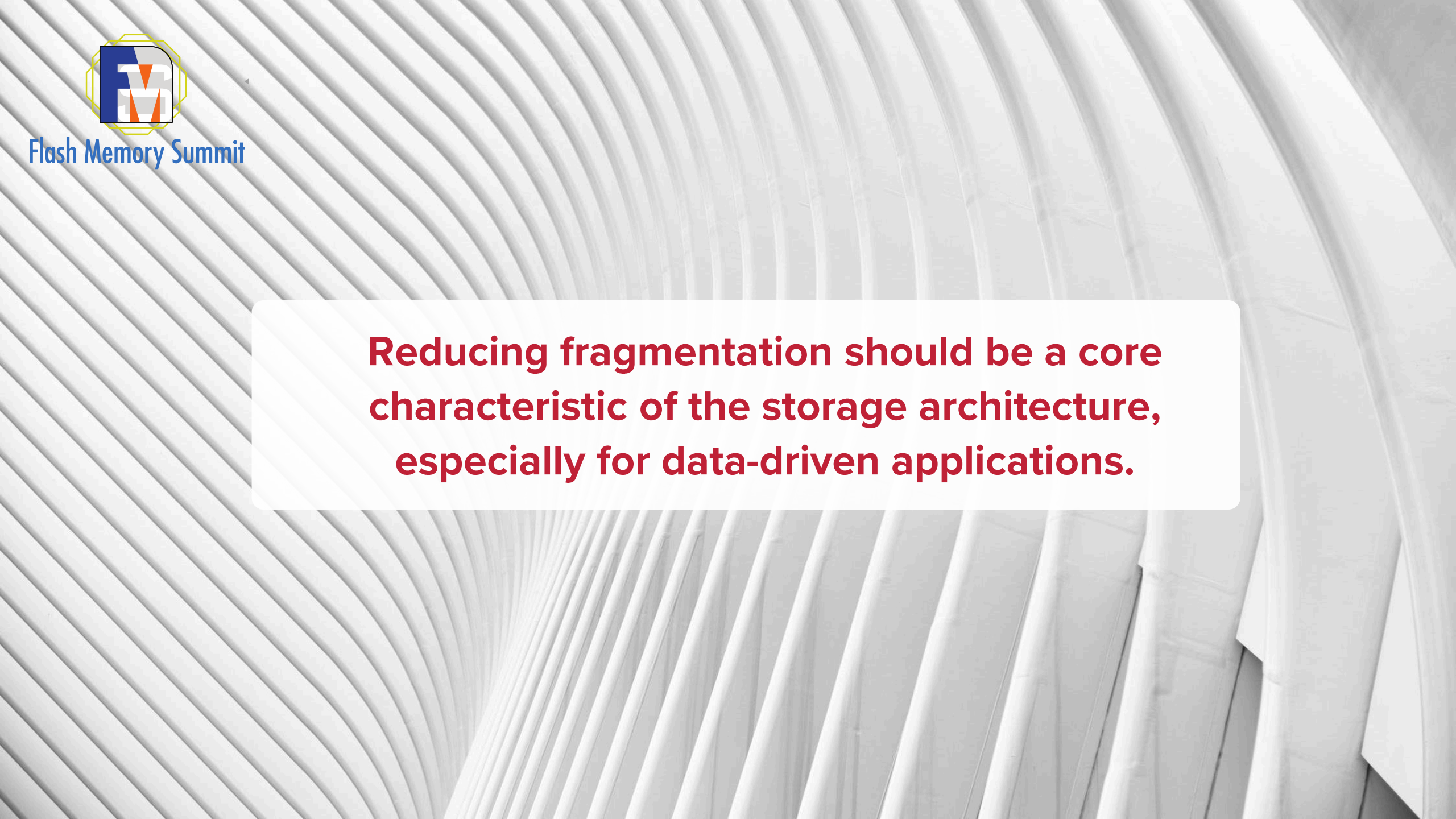
Frame loss and capture lag when recording HD video content



Reduced lifetime of the device

WHAT CAN WE DO ABOUT FRAGMENTATION?



Reducing fragmentation should be a core characteristic of the storage architecture, especially for data-driven applications.

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WHAT SHOULD BE DONE?

Intelligent file system design

Lay out files as logically as possible
with lowest amount of fragmentation

Defragmentation* also an option
*but default tools can reduce flash lifetime

Yongjun Zou
Business Development Director at Tuxera

zou@tuxera.com

(Title) Practical Solution to support both UFS Card and microSD card using single slot

	Zhineng Fan is a Senior Field Application Engineer at Amphenol. He started his interconnector career more than 15 years ago and currently is responsible for early development of new product and industry standards. He graduated from City University of Hong Kong with Ph.D. degree in Physics and Fudan University with master of science degree in Material Science and bachelor of science degree in Physics. He worked at University of California, Berkeley as visiting scholar and Cornell University as research associate. He published 26 papers and was granted 15 U. S. patents.
Zhineng Fan, Zfan@amphenolacp.com, Sr Field Development Engineer	Rise of the 4th industrial Revolution (aka Industry 4.0), follows a path of innovation along with distinct interconnect requirements. Amphenol seek to address the industry needs with the development of UFS card slot connector. Its unique features ensure transmission quality, speed in demanding multi-tasking environment and application diversity such as Mobile Computing, AR, VR, 4k/8k video, Drones, Video Surveillance IP cameras & autonomous automobiles. The following presentation highlights how Amphenol UFS card slot allows YOU (Adopters & ODM / OEMs) to differentiate, win mindshare and win market share. The presentation demonstrates Amphenol UFS card socket designs help industry overcome application challenges

Amphenol UFSA
Universal Flash Storage Association

Practical Solution to support both UFS Card and microSD card using single slot

July 30th, 2018

Amphenol Shouhmin Co. Ltd
Robin Aw / KM Tan
(robin.aw@amphenol.com.sg / km.tan@amphenol.com.cn)


Flash Memory Summit
UFSA
Universal Flash Storage Association
NEW TECHNOLOGY
NEW CHALLENGES
FOR MEMORY CARD SLOTS

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Universal Flash Storage Association

HIGHLIGHTS

Amphenol UFS card slot solution

1. HIGH SI PERFORMANCE 
2. ULTRA LOW Profile 

3. COMPATIBILITY 
4. CONSISTENT PERFORMANCE 
5. HARSH OPERATING CONDITIONS 

CONSUMER MOBILE

SPEED

IS EVERYTHING

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- Flicker free VR images
  = ↓ Giddiness

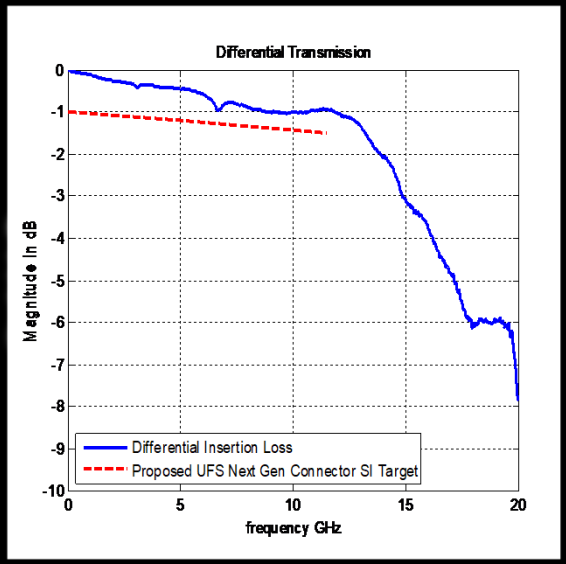
- Allows ↑ Speed R/W
  = Jitter Free Image Viewing / Rendering
  = ↑ User experience

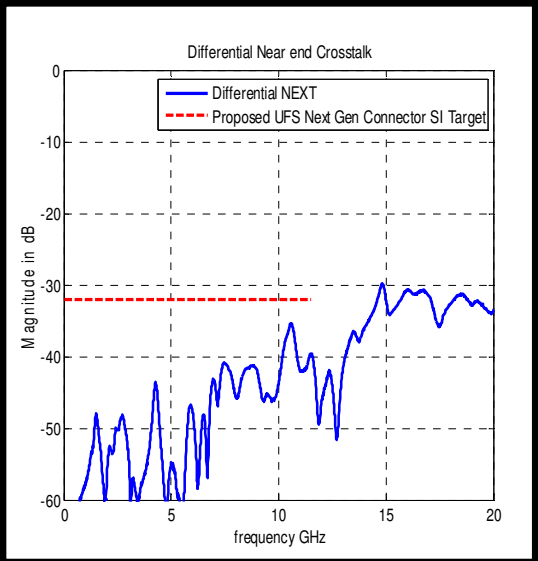
- Amphenol UFS card slot SUPPORT up to 24Gbps (> UFS Card 2.0: Y2020/4Q planned / 12Gbps * 1 lane)
  = Future proofing up to Y2023
  = Ultra HD 8K ready (H.265, 60fps, AVI)

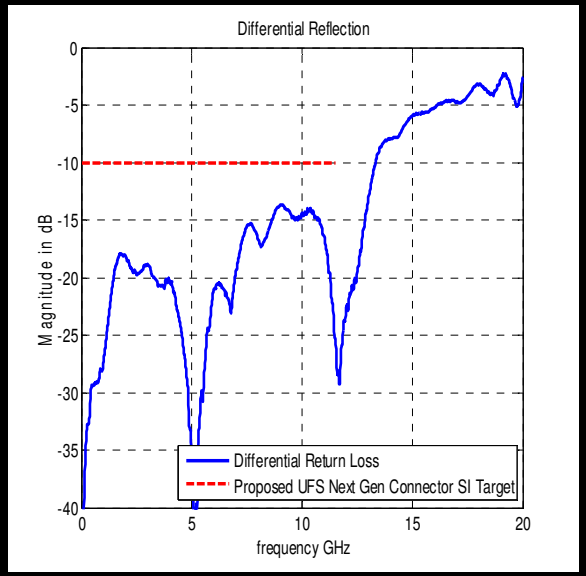
This means:

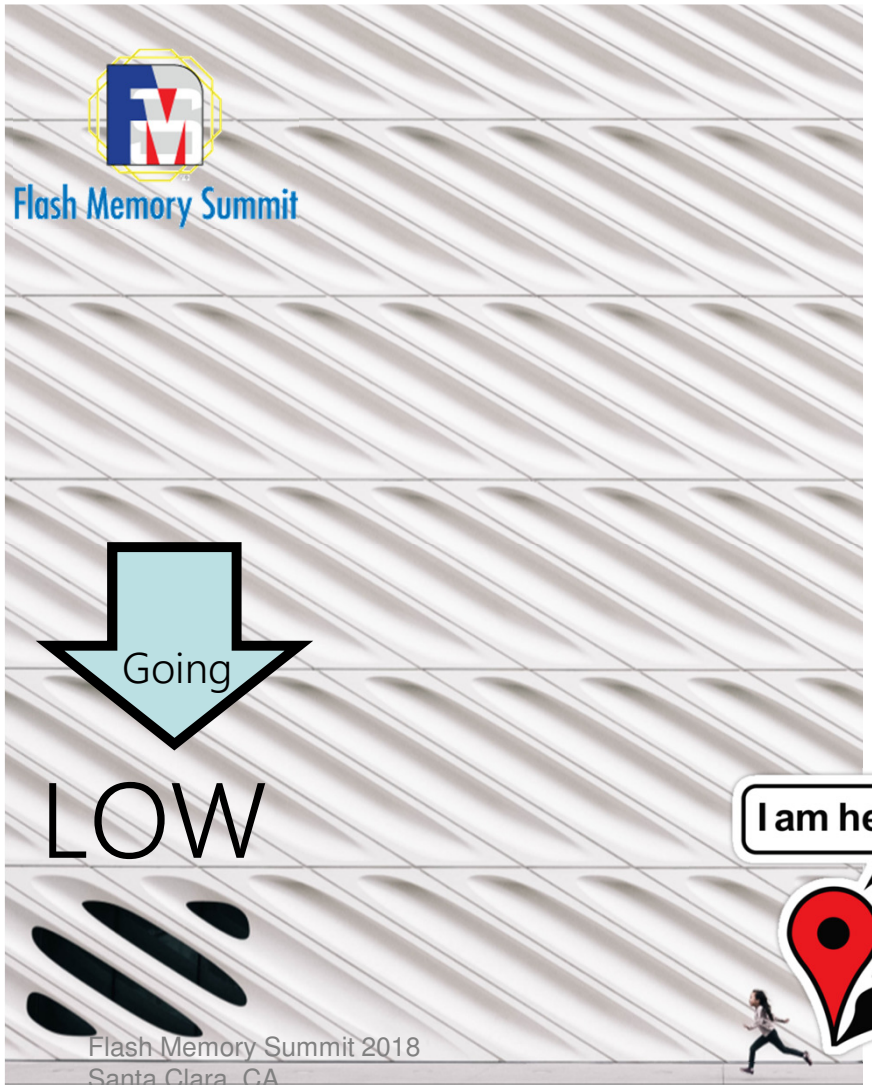
- High speed performance & more engineering buffer for host system design

MEASURED RESULTS
(POTENTIALLY REACHING 24Gbps)









EVERYBODY WANTS

LOW PROFILE

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Amphenol UFS card slot :

- 1.30mm profile height
  (Ultra-low profile in the market)
- Break down**:
  - Mouth of connector 0.90mm (nominal min) to allow max card thickness mating.
  - 0.30mm housing using super high flowing LCP
  - 0.10mm for contact material

Disclaimer **:
Due to IP concerns, figures given in breakdown are estimation and for illustration . They are not representative of the actual dimensional control.

EVERYBODY WANTS

LOW PROFILE

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This means:

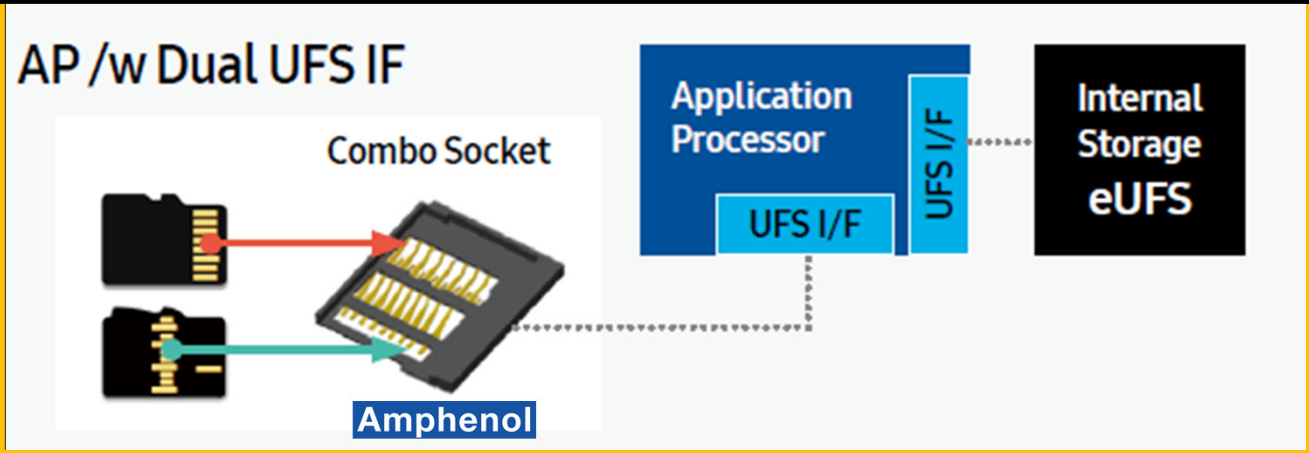
- When facing form factor constraints, Amphenol UFS card slot

IS THE SOLUTION!

Everyone likes COMPATIBILITY

Amphenol UFS card slot design:

- Accepts Micro SD UHS I cards
- Backward compatible to Legacy SD bus interface



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HARSH

ENVIRONMENT MATTERS

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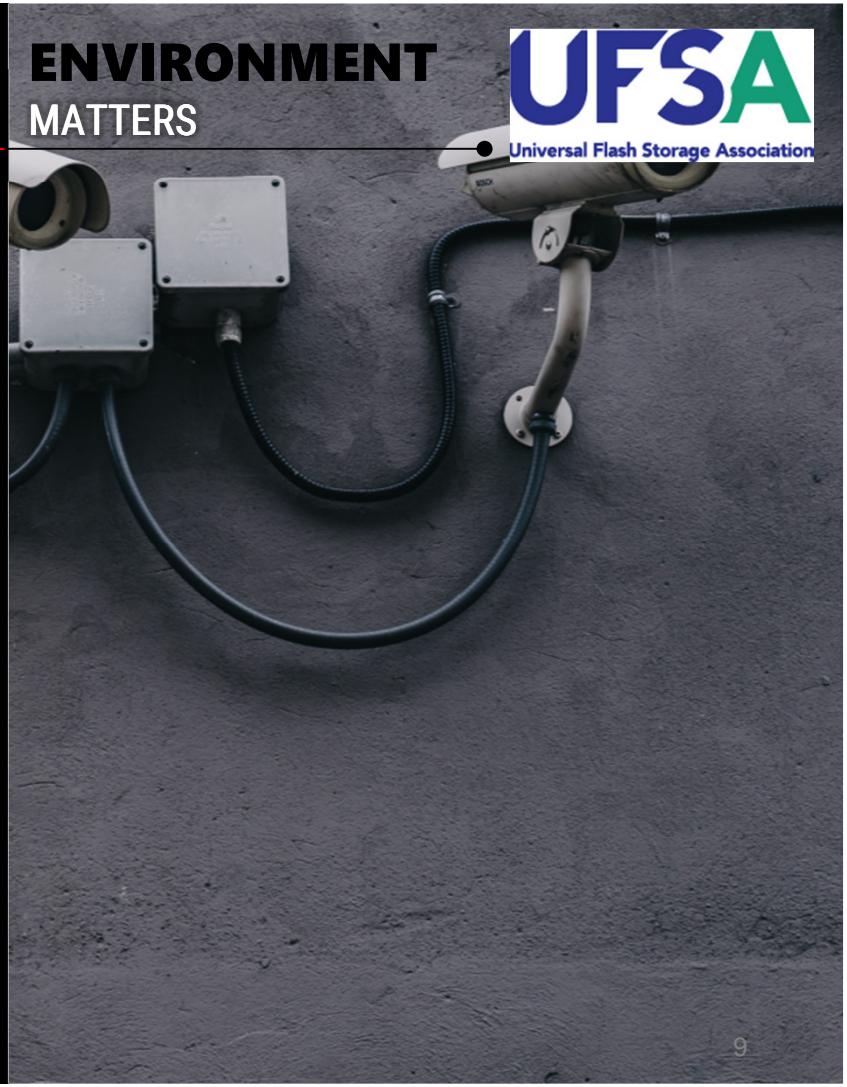

- Emerging AI automatic surveillance
  = Need Edge computation + Storage
  = Exposed to HARSH conditions

- HARSH New requirements
  = High / Low Temp & Corrosive Industrial conditions (ambient)

- Amphenol UFS card slot SUPPORTs
  > Operating Temperature (-40°C ~ 85°C)
  > 3 year Field life minimum. MFG Class IIA
  EIA 364, Test Procedure 65A

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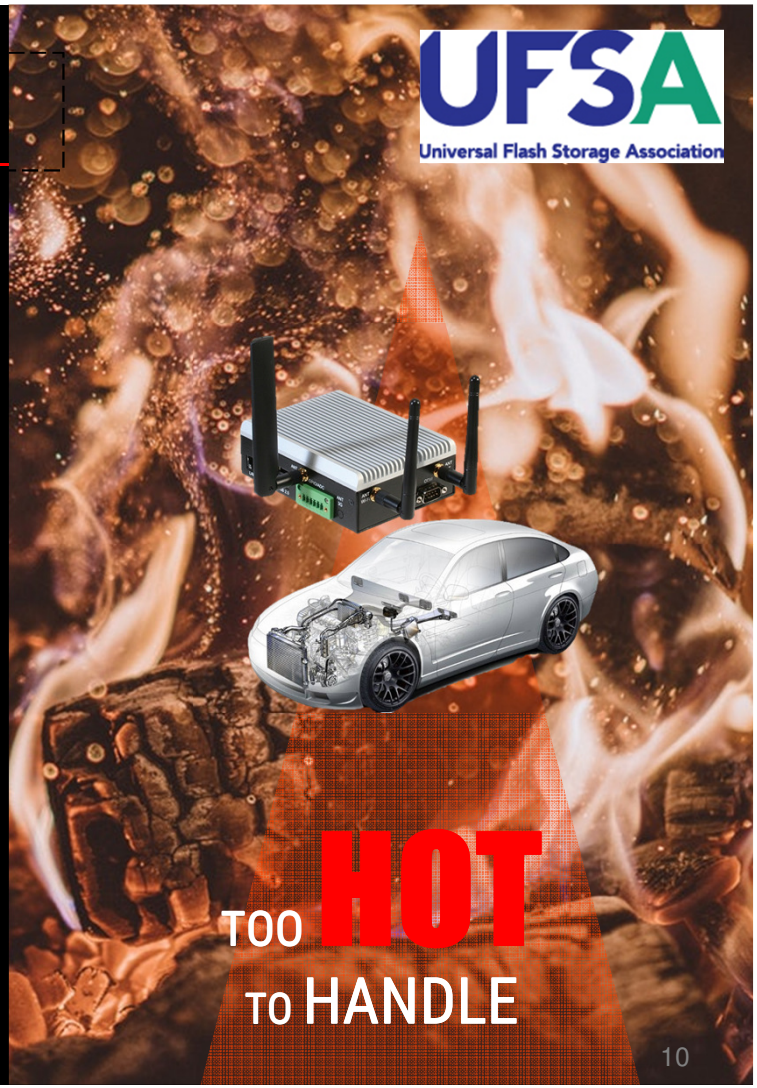
Thermal concerns ?!

Requirement

- IIOT / Automotive calls for Fan-less design in embedded device
- = LLCR ↑ must be within manageable means when the ambient temperature ↑.



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Thermal concerns ?!

Amphenol UFS card slot design:

- Typically LLCR ↑ < ~2mΩ max ** from ambient 25°C to 85°C

This means:

- Performance not affected in high Temperature environment

Thermal
concerns ?!

Requirement

- High Performance = High Power = ↑ Temperature
- = Temperature rise must be within manageable means when in high power / high performance applications.

Thermal concerns ?!

Amphenol UFS card slot design:

- Based on (EIA 362-70):
  Temperature Rise < 30°C
- Simulate Extreme performance scenario:
  ✓ Temperature Rise Test - Transmit 0.8A to 4 * pins via a 3.2A source

This means:

- Amphenol UFS card slot thermal profile is manageable even in high performance (high power) conditions.

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WHATS ON THE MENU?

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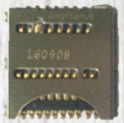
3 CHOICES for Standard Types

Push - Pull	H = 1.5mm
Push - Push	H = 1.3mm
Pin - Push	H = 1.3 mm



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2 TRAY TYPE COMBO SOCKETS

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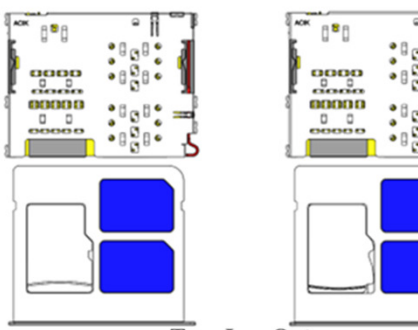
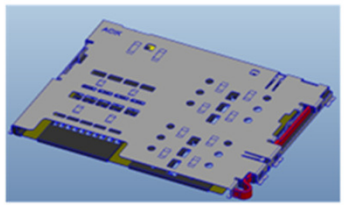
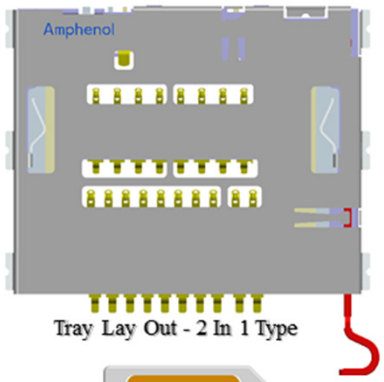
UFS combo 4 in 3



Tray Lay Out
- 4 In 3 Type



UFS combo 2 in 1



Tray Lay Out - 2 In 1 Type

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TAKEAWAYS

Amphenol UFS Card Slot:

1. HIGH SI performance: SUPPORTs up to 24Gbps
2. ULTRA LOW profile height; 1.30mm
3. COMPATIBLE with Micro SD UHS I cards & legacy SD bus.
4. CONSISTENT PERFORMANCE even in elevated thermal conditions
5. SUPPORTS WIDE Operating Temperature & Harsh conditions : (-40°C ~ 85°C) & MFG Class IIA


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Amphenol
”Don't be afraid to give up the good to go for the great"
Q AND A
Any Questions?

(Title) Measurement solution for integrating ultra-high speed UFS storage

	Perry Keller is the Program Lead for Keysight's Digital applications and Standards Program and manages its memory applications program. He has 30 years of experience at Keysight Technologies in the areas of software and system engineering, high speed hardware and ASIC design and validation, software engineering, product marketing, and project management. Perry graduated in 1980 from Rice University with a Masters Degree in Electrical Engineering. He has two daughters and enjoys bicycling and skiing in his spare time.
perry_keller@keysight.com, Perry Keller, Applications and Standards Program Lead Memory Applications Manager	UFS adoption is accelerating, extending beyond cell phones and tablets to high end embedded systems, drones, even automotive computing and infotainment. From initial pomeron to final product certification, reliable test and measurement is central to validating, characterizing and troubleshooting the entire system. And, UFS 3.0 doubles the speed of what was already one of the fastest interfaces in your design. As a result, an increasing number of design teams are having to update or overhaul their labs and test plans to be ready when 1st silicon arrives. This session will help you understand how to evaluate your current test and measurement capabilities and prepare the easiest, most effective path to successful pomeron, integration, and final certification of compliance of your design.

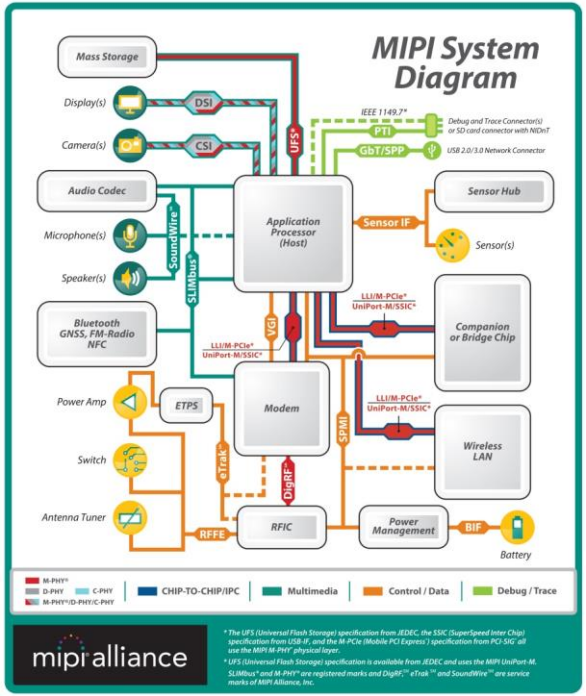
Integration of Ultra High Speed UFS Storage

Characterization and Compliance Measurement

Perry Keller

Keysight Technologies

Your System



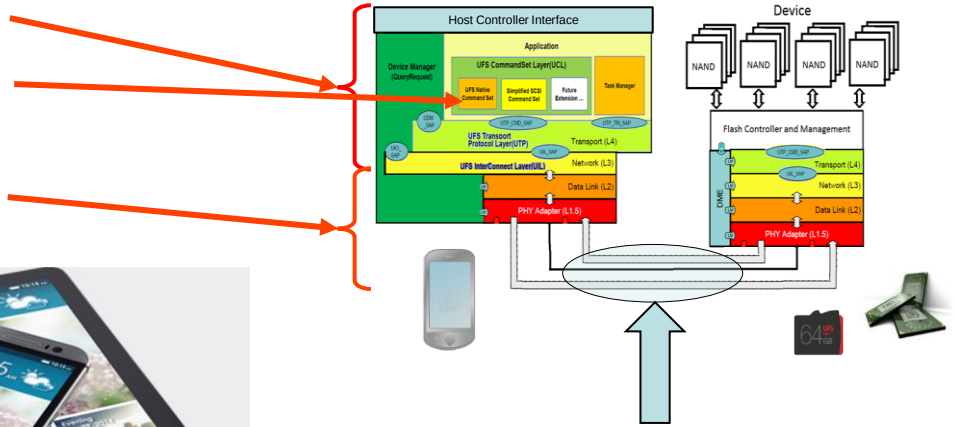
* JEDEC, MIPI Alliance and UFSA logos are the property of their respective organizations

UFS is State of the Art

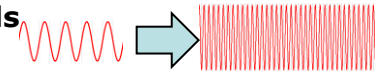
Server-class multi-threaded protocol

Best-in-class technologies

- JEDEC UFS
- T10 SCSI
- MIPI M-PHY
- MIPI UniPro

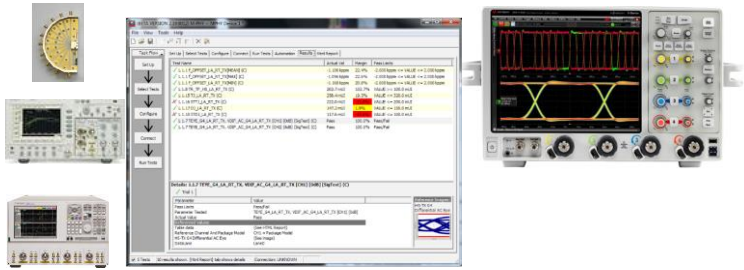


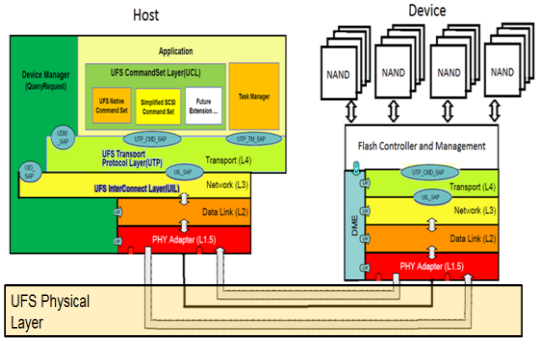
UFS data moves at microwave speeds



M-Phy Physical Layer

- **Typical platform components:**
  - **Metrology grade test fixtures**
  - **Oscilloscopes**
  - **Bit Error Rate Testers**
  - **Waveform generators**
  - **Network Analyzers**
  - **Time Domain Reflectometers**



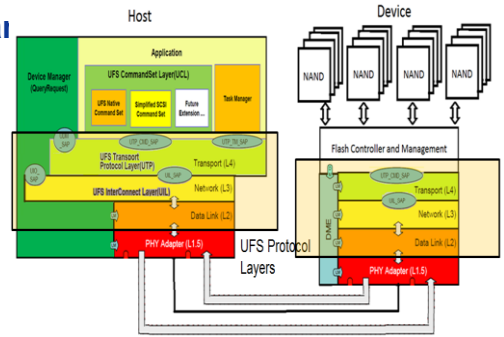


➢ Scope of testing

- **M-Phy Tx**
- **M-Phy Rx**
- **UFS channel (Tx ball to Rx ball)**
- **Power integrity (future)**

UFS and Unipro Protocol

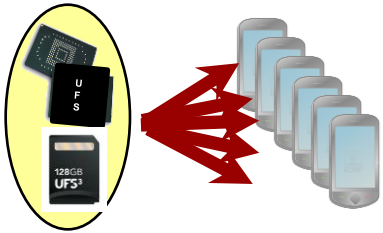
- **Typical platform components:**
  - **Host, Device, snoop test fixtures**
  - **Oscilloscope protocol decoder**
  - **Protocol analyzer**
  - **Protocol generator/exerciser**
  - **Instrumented “golden” hosts a**



- **Scope of testing**
  - **Unipro**
  - **UFS Transport Layer (UTP)**

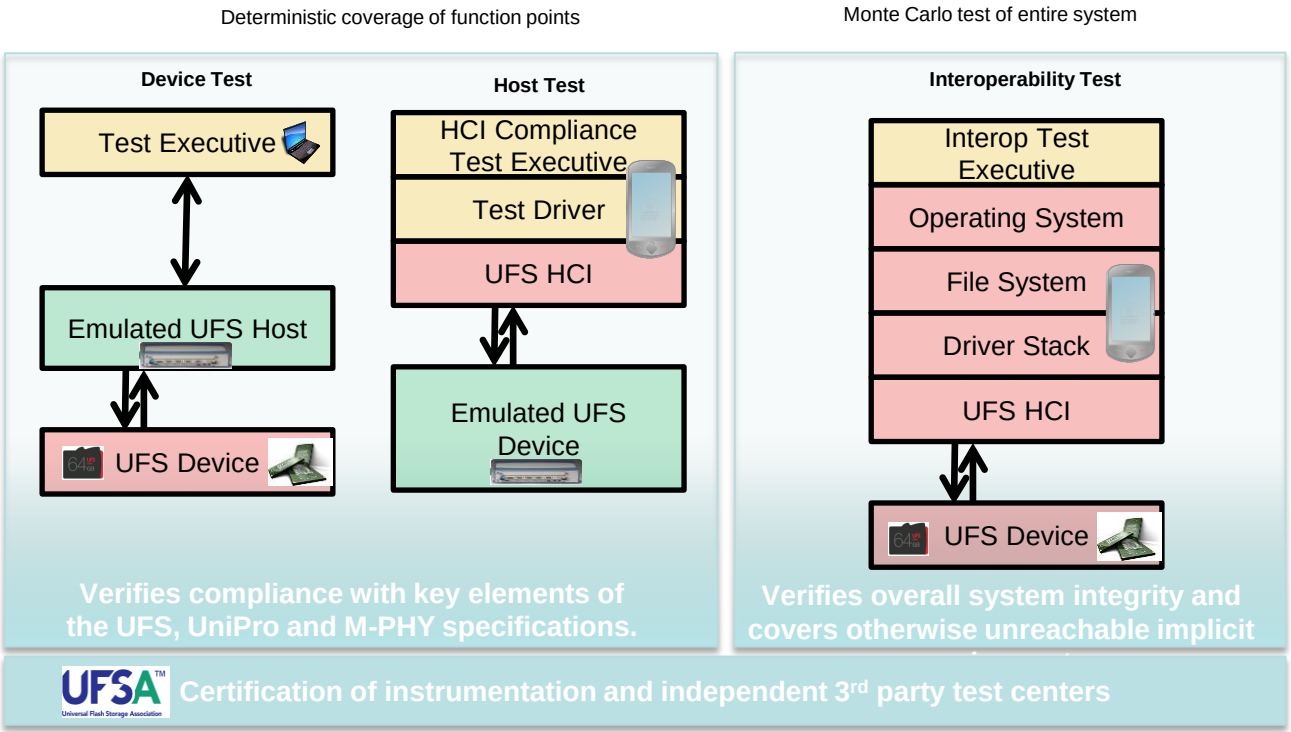
Interoperability Testing

- **Typical platform components:**
  - Host, Device, snoop test fixtures
  - Set of "Golden" hosts (for device test)
  - Set of "Golden" devices (for host test)
  - Host test application or procedures
  - Phy/Protocol test equipment (for debugging)

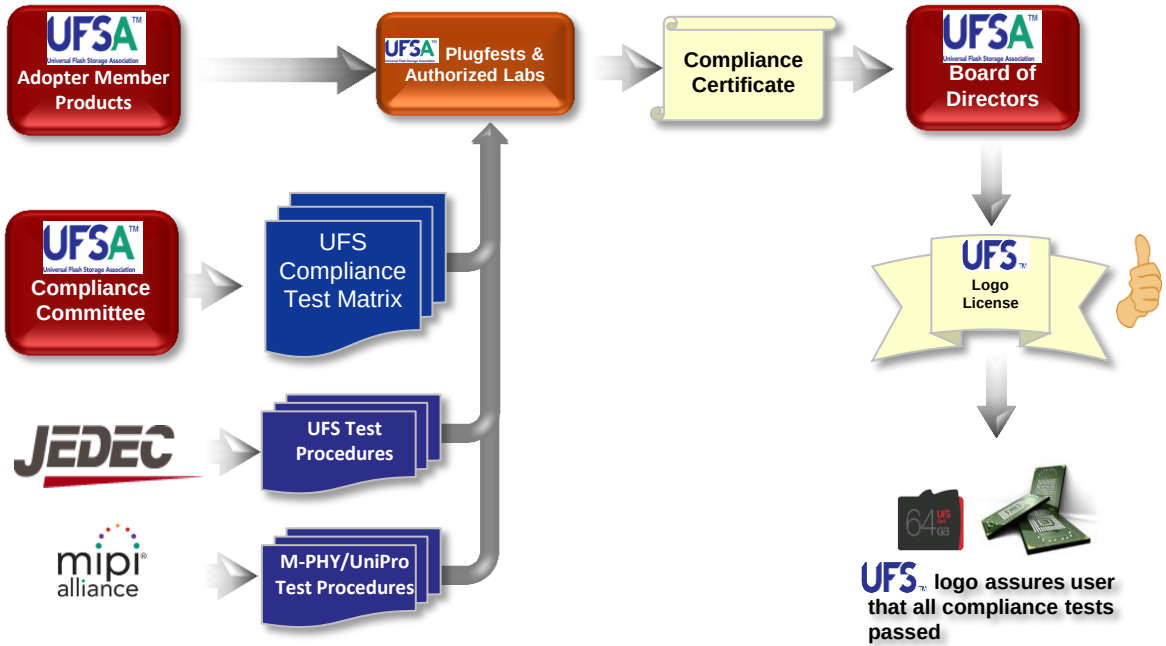


- **Scope of testing**
  - Complete UFS HW/SW stack
  - Interoperation with defined set of "Golden" hosts/devices

UFS Compliance Test Architecture



UFS Logo Certification Process



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The Assurance of Quality for You AND Your Customer

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